Koh Rong Samloem and Koh Kon Marine Environmental Assessment

Preah Sihanouk Province

Report on Marine Resources and Habitats

Marine Conservation Cambodia

For Fisheries Administration: Fisheries Conservation Department
May 2011

Photo 1 – Soft Coral, Koh Rong Samloem

planetaction

Report By:

Bonny Krell – MA Applied Ecology

Marine Skopal – MA Integrated Coastal Management (ICM) – ICM Project Manager

Paul Ferber – Managing Director and Project Founder

ACKNOWLEDGEMENTS

Thanks are due to a great many people for helping to make the project a success. Of prime importance in the establishment and continued work carried out are the Fisheries Administration of Cambodia in Phnom Penh and in Kampong Som for their support and the Community of M'Pai Bei (Village 23) on Koh Rong Samloem who have provided the project with a home.

H.E. Mr. Nao Thuok	Director General of the Fisheries Administration
Ms. Kaing Khim	Deputy Director Fisheries Administration
Mr. Ouk Vibol	Director of Fisheries Conservation Department
Mr. Prak Visal	Project Coordinator of Integrated Coastal Management (ICM) – Provincial Hall of Preah Sihanouk Province
Miss. Nay Sally	Project Management Office (PMO) staff – Sihanoukville ICM Program – Provincial Hall of Preah Sihanouk Province
Mr. Thay Somony	National Project Coordinator of Regional Fisheries Livelihoods Program (RFLP), FAO
Mr. Yos Chanthana	Consultant for Fisheries Co-Management, RFLP/FAO
Mr. Nen Chamreun	Deputy Director of Community Fisheries Department, FiA
Mr. Daich Sokhom	Koh Rong Sangkat Chief
Mr. Lay Thay	Koh Rong Samloem (Village 23) Community Chief

Koh Rong Samloem Community Fishery (Village 23)

All Marine Conservation Cambodia Staff and Volunteers

ABSTRACT

Upon request from the Department of Conversation of the Fisheries Administration (FiADC) Marine Conservation Cambodia (MCC) undertook a series of marine surveys to assess the health of the marine ecosystems around the islands of Koh Rong Samloem and Koh Kon, Preah Sihanouk Province, Cambodia. . A total of 49 sites have been surveyed by the MCC Research Team between February and April 2011 using the Reef Check methodology. Results of this study indicate that at the 49 sites surveyed, the overall hard coral cover on the fringing reefs surrounding these islands is around 13%. Rock, which is potentially suitable settling grounds for coral larvae, constituted another dominant substrate (28%). Several damages to corals have been observed mainly resulting from fishing trash. Bleaching and coral disease did occur in low intensity at the time of the surveys, nevertheless should be closely monitored. Anchor damages have been observed to be dramatically increasing within and outside of the survey areas. Overfishing has been observed for both fish and invertebrates. It is clear that the marine resources around the islands of Koh Rong Samloem and Koh Kon are under strain and need active protection to stop the degradation of the Coral Reefs and High Biodiversity Areas. Community protection has proved to be successful with a very active patrol group causing a significant decrease in illegal fishing and destruction of sensitive habitats. However, continuing support from relevant government departments will be necessary in order to carry on the protection and sustainable management of the area.

Marine Conservation Cambodia
Koh Rong Samloem Village, Koh Rong Samloem
Mittapheap District, Sihanoukville
CAMBODIA
maskop@marineconservationcambodia.org

MARINE SURVEY TEAM

Ueli Schmid	Marine Research Coordinator, MCC
Bonny Krell	MA Applied Ecology – Marine Research Team, MCC
Julia Herbolsheimer	MA Fisheries Science - Marine Research Team, MCC
Carly Atkins	Bsc - Science Officer, MCC
Daniel Widmann	Marine Research Team, MCC
Jan Schill	Marine Research Team, MCC
Jacqueline Dodd	Marine Research Team, MCC
Marine Skopal	MA ICM - ICM Project Manager, MCC
Bouk, Rong & Gao	Dive Boat Captains, MCC

CONTENTS

TABLES AND FIGURES

PHOTOGRAPHIES

All pictures taken by MCC team and volunteers.

LIST OF ABBREVIATIONS AND ACRONYMS

CFA	Community Fishery Area
CFi	Community Fishery
FAO	Food and Agriculture Organization of the United Nations
FiA	Fisheries Administration
ICM	Integrated Coastal Management
KK	Koh Kon
KRS	Koh Rong Samloem
MCC	Marine Conservation Cambodia
MFMA	Marine Fisheries Management Area
MPA	Marine Protected Area
RFLP	Regional Fisheries Livelihoods Programme
RGC	Royal Government of Cambodia

INTRODUCTION

Cambodia has a 435km long coastline which includes 69 islands within the Gulf of Thailand (Touch, 1995). Many of these islands have coral reefs and associated seagrass beds and/or mangrove habitats in their periphery, providing crucial habitats for a great diversity of marine species. These habitats provide significant economical goods and services that are critical to human well-being (Conservation International, 2008). Cambodia's economy is highly dependent on the Coastal and Marine sector in term of services provided: ecosystem goods (food, raw materials…), coastal protection (climate regulation, moderation of extreme events, waste treatment…), marine tourism and ecotourism and biodiversity (Bryant et al. 1998).

Coral reefs, by being a crucial habitat for a lot of marine species, support the fisheries (a large number of households nationwide depend on the primary sector as their main source of employment and income (Wheeleret.al, 2000). A wide variety of economic valuation studies have been made on coral reefs and related systems around the world, with a focus on ecosystem goods and services namely tourism, fisheries, coastal protection, biodiversity and carbon sequestration. An economic analysis of Ream National Park in Cambodia, looking at social, economic and ecological data, estimated the Present Value (10% discount, 20 years) of the best protection scenario at $11,9 million per km^2 of healthy coral reef (Conservation International, 2008).

Unfortunately, these services are at risk as coral reefs are threatened by destructive fishing methods and overharvesting, as well as siltation, sewage, agricultural garbage, mining and industrial pollution, coastal development, global warming and tourism-associated damages (Kim et al, 2004;Jones et al., 2004; GCRMN, 2004; Bruno &Selig, 2007;Knowlton & Jackson, 2008). Foreign illegal and destructive fishing, poaching, as well as inshore trawling constitutes the main threats to Cambodia's coral reefs with a lack of resources, making it difficult for local authorities to tackle.

An increasing number of nations worldwide have realized the urgent need for proper coral reef management as an unquestionable imperative to be able to keep up with current global demographic and socio-economic changes. A decrease in coral reef productivity has been shown to cause major socio-economic and ecological problems and is bound to affect some of the main sources of national income such as fisheries and eco-tourism. Reduction in reef productivity can disrupt the entire food chain,

causing a decrease or definite loss of commercially valuable goods. Indeed, several corals and other marine animals and plants with low resilience capacity might not be able to resist to such changes of their natural environment thus unable to return to their original ecological state after disruption has occurred (Rogers, 1990). Future projections made by the Global Coral Reef Monitoring Network (GCRMN) estimate that Cambodia's reefs will be either at "high" (90% of reefs) to "very high" (10% of reefs) risk (in Wilkinson, 2008).

Information about Cambodia's reef systems is sparse and only limited research exists (Chou, 2003, Wilkinson, 2008). The Fisheries Administration understands this urgent need for accurate data on the current status of these critical habitats and how to best protect them.

The islands of Koh Rong Samloem (KRS) and Koh Kon (KK) are found off the *coast of* Preah Sihanouk Province (**Figure 1**). Koh Rong Samloem is home to M'Pei Bai Community (Village 23), registered as Community Fishery since 2009. Around 45 families live in Koh Rong Samloem Community Fishery, most of them depending on fisheries resources and increasing eco-tourism. Village 23 has been managing and protecting its Community Fishing Area through the assistance of partner organization MCC and is now seeing the benefit of sustainable fishing and marine eco-tourism. The island of Koh Kon is inhabited and buffered by a 300m no fishing area.

The main goals of this survey were:

- To determine the general distribution of coral reefs around Koh Rong Samloem and Koh Kon Islands and to conduct baseline quantitative surveys on the abundance and distribution of reef health indicators such as fish and invertebrates.

- To determine the general reef condition in terms of visible impacts.

- To identify sites for future monitoring programs.

- To identify areas with high biodiversity and healthy coral reefs for the purpose of sustainable fisheries management, marine conservation and the creation of a Marine Fisheries Management

Area (MFMA) and associated Zonal Management Plan aiming at developing the area as a sustainable eco-tourism destination.

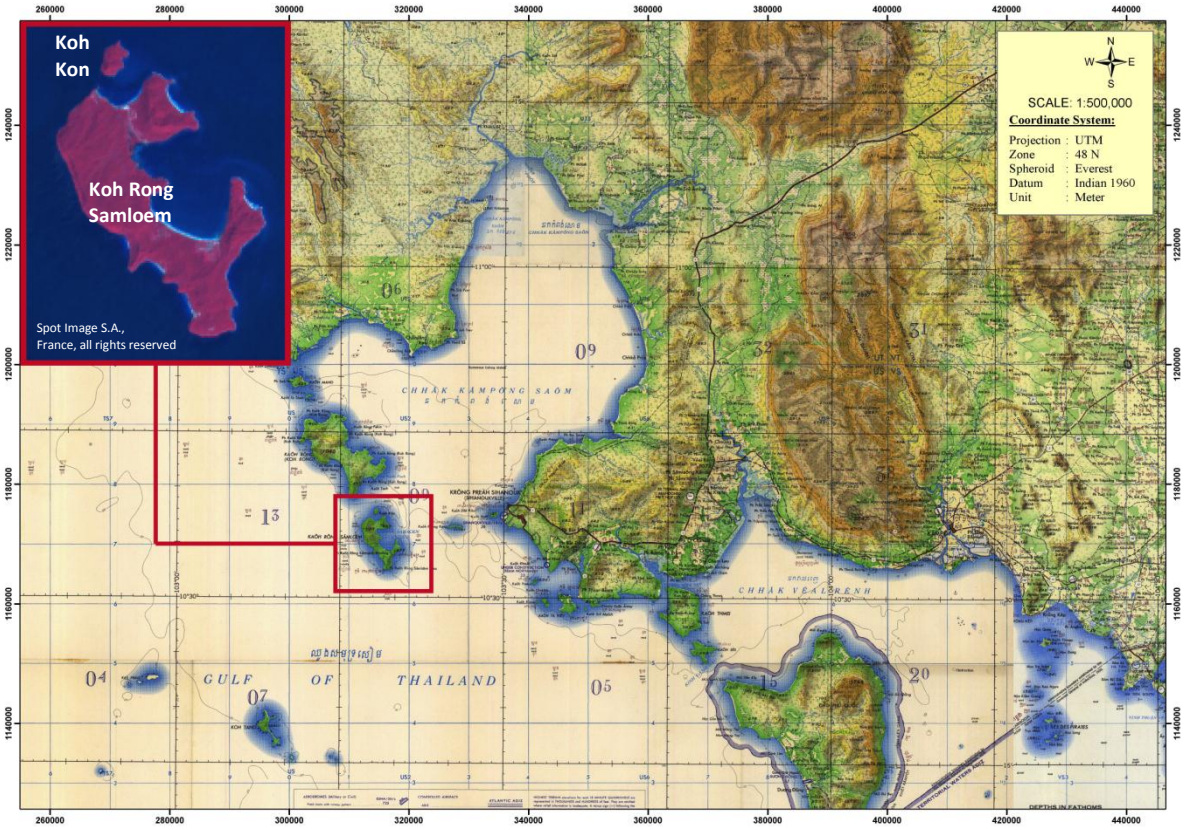


Figure 1 – Coastal Cambodia: close-up on Koh Rong Samloem & Koh Kon

I. METHODOLOGY

Standard Reef Check monitoring was applied for the survey sites around Koh Rong Samloem and Koh Kon Islands in order to assess the abundance, diversity and composition of selected fish, invertebrate and benthic species. This methodology was used as it provides a rapid assessment of coral reef condition and health. Furthermore, it is quick and reliable and based on pre-defined criteria and descriptors.

a. Location of survey sites and reasons for their selection

Figure 2 - Location of survey sites around Koh Rong Samloem and Koh Kon

For this study, 49 survey sites were chosen around Koh Rong Samloem (43 sites) and Koh Kon (6 sites) (Figure 2). The sites around Koh Rong Samloem (KRS) and Koh Kon (KK) were chosen in advance to get the best overall view of the shoreline area then adapted to suit the conditions at the time of surveying. Site 1 and Site 11 were relocated as were several other sites whose original random coordinates would have placed the surveys on land. In addition, the starting point of each site was chosen at random and four 20-meter (m) transects were laid parallel to the coastline to make up one complete segment. Each 20m segment was separated by a minimum gap of 5m. In these 5m gaps no data was recorded, as this is needed to ensure independence for each 20m section and provide reliable statistics. Due to the geomorphology of the areas, only shallow transects were carried out between 2m and 10m. The recorded data has been transferred to standard data forms.

In Cambodia, southwesterly monsoons winds dominate from April throughout October followed by drier northeasterly winds that prevail from November to March. Therefore the northeastern part of the islands of Koh Rong Samloem and Koh Kon are sheltered from April to October whereas the southeastern parts of the island are sheltered from November to March (Figure 3).whereas the southeastern parts of the island are sheltered from November to March (**Figure 3**).

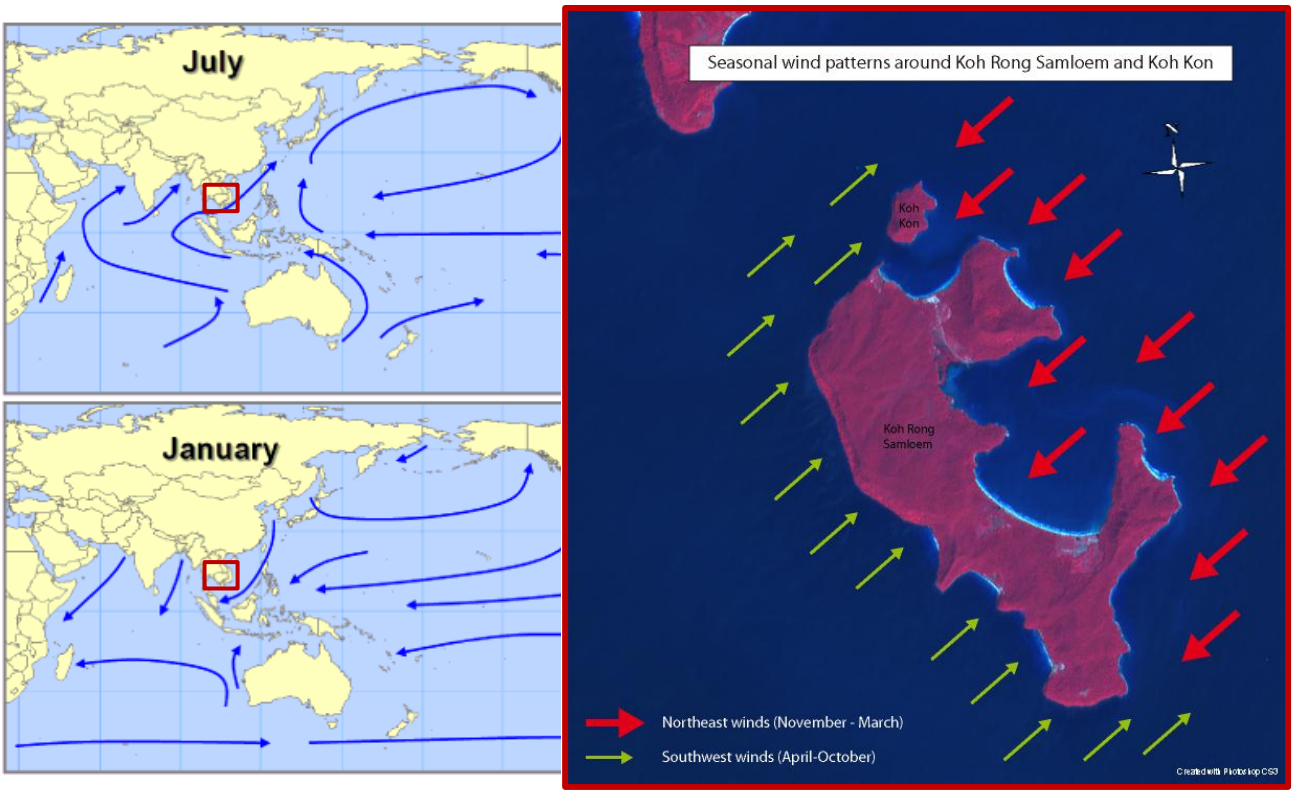


Figure 3 – Global seasonal wind patterns with close-up on the islands of Koh Rong Samloem and Koh Kon

b. Type of data collected at each survey site/transect

An overall description of each site was recorded. This included: Basic information, natural and human impact, historical facts and protection enforcement. Based on their effectiveness as indicators of overall reef health, certain target species have been chosen by Reef Check. A history of overfishing, aquarium collection, nutrient pollution and sedimentation can all be indicated by these variables. More specifically, the Reef Check methodology designates three different transects: a fish belt transect, an invertebrate belt transect, and a substrate line transect (**Figure 4 and 5**).

In order to complete the fish belt transect, divers recorded fish families, recognized as being good indicators of fishing pressure, aquarium collection and reef health. Size minimums were placed on two families of food fish – Groupers and Parrotfish. Data was recorded in an area 2.5m on each side of the transect and 5m above. Since fish get easily disturbed by divers the fish belt transect was completed first. In order to record an accurate assessment of the fish population, this portion of the survey was conducted by swimming slowly along the transect, counting the indicator families and species.

The same four 5m wide and 20m long segments were used for the invertebrate belt transect. The divers executed this portion of the survey by swimming slowly in an S-shape pattern on each side of the transect counting the indicator invertebrate species typically targeted as food species or collected as curios. To ensure accurate results, surveyors looked into holes, burrows and cavities.

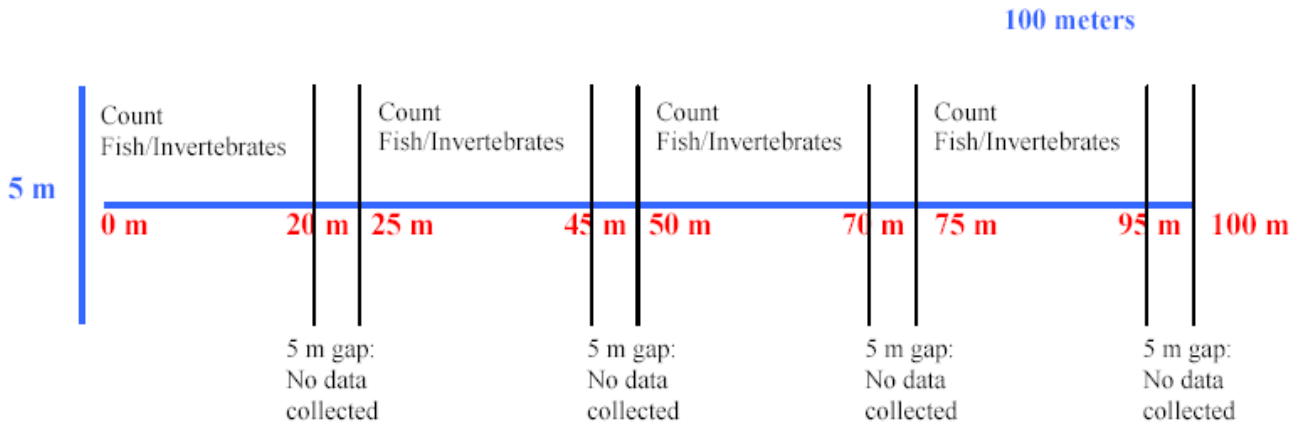


Figure 4 - Fish and invertebrate belt transect count method (in Hodgson et al., 2006)

This transect was used again to conduct the substrate line transect. In a 0.5m interval along the tape, points were sampled to determine the substrate of the reef. The benthic categories used in this assessment included: hard coral, soft coral, recently killed coral, nutrient indicator algae, sponge, rock, rubble, sand, silt/clay and other. Moreover, along the transect line, divers estimated the total percentage of bleached coral cover as well as the estimated percentage of each individual coral colony that is bleached. Coral diseases were recorded as a percentage of the colony infected and where possible, the disease was identified. Damage was recorded on a categorical scale from 0 to 3 (0 = none, 3 = high). Trash was recorded and separated into general and fishing nets/traps. Coral damage types were broken down into boat/anchor, dynamite and other.

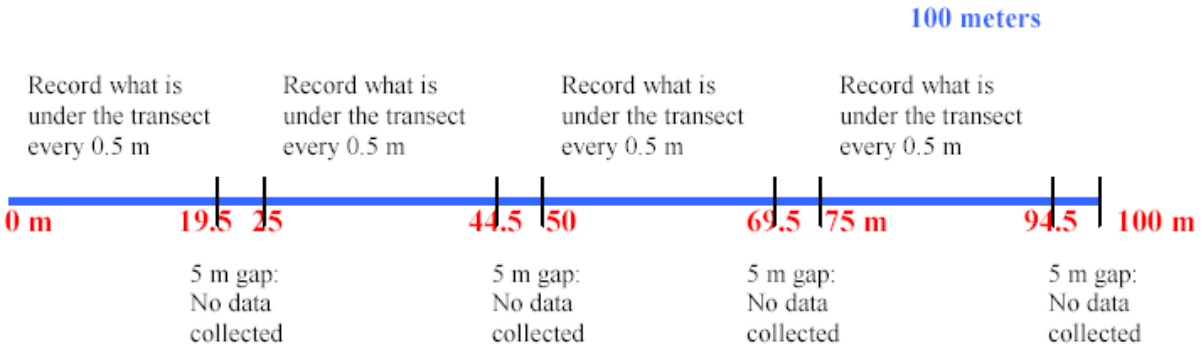


Figure 5 - Point intercept transect count method to determine benthic cover (in Hodgson et al, 2006).

After data had been collected using the Reef Check methodology, divers swam along the transect and collected extra information on species present at the survey sites. The purpose of this was to create a database list with all marine species that were witnessed during the surveys around Koh Rong Samloem. This could be used in the future to create a complete inventory of marine species present around the Island.

c. Data entry & analysis

Data analysis is based on 49 X 100m Reef Check surveys conducted along the fringing reefs of Koh Rong Samloem (KRS) and Koh Kon (KK) between February and April 2011.

To determine the cover percentages of each survey site, the mean percentage of substrate cover, of the four transects was calculated. The total cover composition around the islands of KRS and KK was estimated by the average composition of all survey sites.

Coral damage was estimated as the mean of the four transects. A stacked column graph has then been used to compare coral damages between sites.

Bleaching was estimated for coral population and colony. The mean percentage of all sites was calculated by the average bleaching around the island. Coral disease was estimated for coral population and the mean percentage was calculated by the average coral percentage affected by disease. The disease has been identified based on the Underwater Cards for Assessing Coral Health on Indo-Pacific Reefs (Beeden et al., 2008)

Survey sites where no corals have been recorded were eliminated from the analysis for bleaching, coral disease and coral damage to get a more realistic result of coral damage around the island.

For the fish and invertebrate transect, the mean number of individuals per square meter has been calculated for each site. Sites have been compared using the stacked column graph. In the case of the invertebrates the Diadema urchins due, to their elevated number, have been analysed separately to allow a proper analysis of the rest of indicator invertebrates.

II. RESULTS

The results from these surveys are shown in a graphical format and aim to provide a picture of Koh Rong Samloem and Koh Kon coral reef status.

a. Substrate composition (Figure 6)

The dominant substrate cover encountered on surveys was sand (36%). The average hard coral cover within the area, was found to be 13%. The highest coral cover was found on Site KRS 40 (49%) and site KK01 (46%), while on Sites KRS11,17,18,19,20,41,42 and 43 no hard coral was recorded (**Figure 8**). Hard coral cover is an indicator of general reef health because they are reef builders, and it is recognized that reef fish diversity is directly related to it. Rock was one of the dominant substrates with an average

cover of 28%. Site KRS23 and KK06 had a particularly high rock cover (72.5% and 81.25%, respectively). Rock constitutes an important part of reefs as it provides settling ground for coral larvae. In general, the percentage of recently killed coral was low (< 5%) with exception of site KRS02 and KK03 (9% and 16%, respectively). Nutrient Indicator Algae was found on few sites, generally not representing more than 5% of the substrate of the survey sites. This is to be expected as there is no terrestrial runoff or other nutrient enriching activities on these islands. However, future development, if not well managed, will most likely affect sediment runoff to the sea thus impacting the health of coral reefs. Exceptions were sites KRS34 and 36 where nutrient indicator algae represents 12,5% and 18,125% respectively. These signs of eutrophication in this area lead to the conclusion that there *might* be an unknown source of nutrient input and would need further research. Sponge cover around the islands was low (2,5%). Site KRS09, had the highest sponge cover with 11% (**Figure 6**). Soft corals were also present in a low percentage, less than 1%. The highest soft coral cover was on sites KRS28 and KRS37 with 5%. Siltation was very high at sites KRS16, 17 and 20 (62%, 100% and 93% respectively). Rubble comprised 11% of the substrate cover with the highest presence at site KRS03 (65%). Other substrates such as anemones, tunicates etc. represent 1% of the substrate cover. These organisms are non-reef building species.

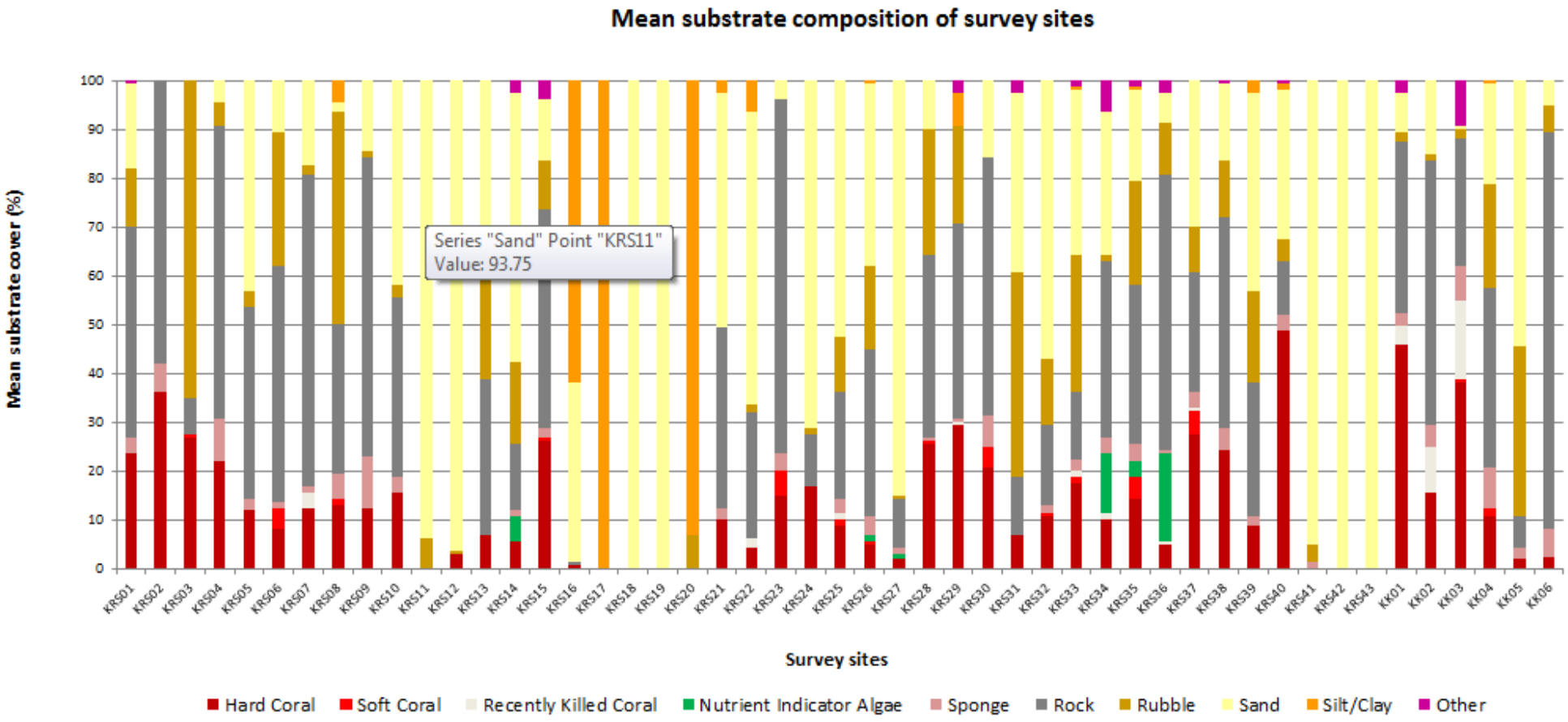


Figure 6 - Composition of mean percentage of substrates cover at the 49 survey sites.

As rubble is unattached to the reef, wave action makes it tumble around, which may knock off any new corals that have settled making it a bad place for coral settlement and therefore reef recruitment. When silt covers corals and these are not able to clean themselves from it then silt may lead to coral starvation. Sand is recognized as a no reef area. These three kinds of substrate represented more than half (53%) of the substrate cover (**Figure 7**).

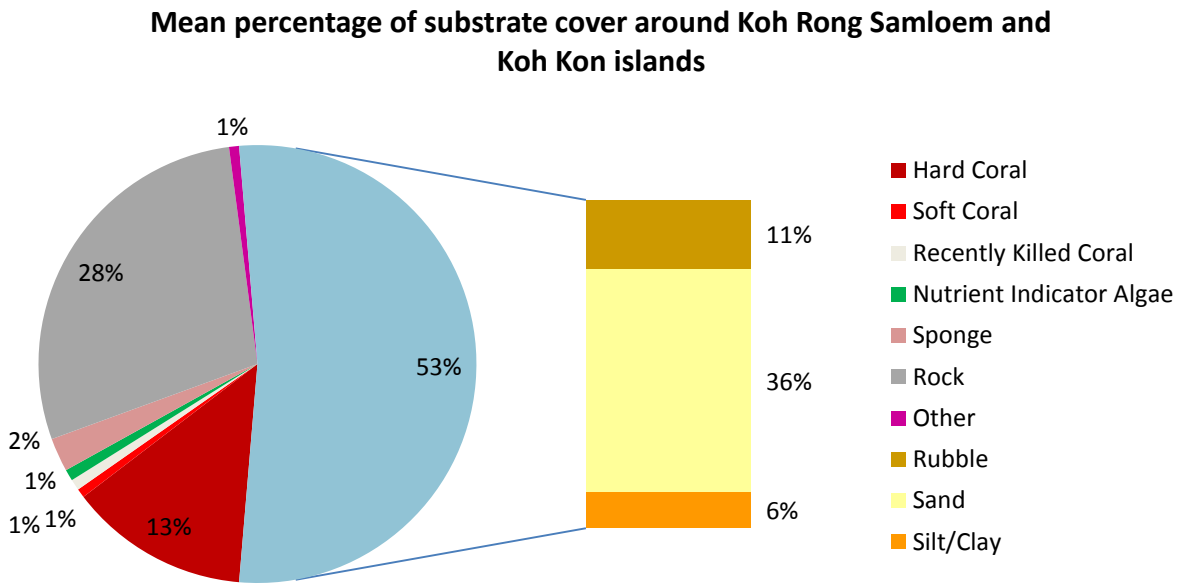


Figure 7 - Estimated substrate composition around KRS and KK islands

Hard Corals that have been seen during the surveys around the islands did belong to the following families:

- Poritidae (**Photo 2**)
- Acoporidae (**Photo 3**)
- Agariciidae (**Photo 4**)
- Dendrophhylidae (**Photo 5**)
- Faviidae (**Photo 6**)
- Fungiidae (**Photo 7**)
- Mussidae
- Siderastreidae

The ones that have been seen most were massive Porites followed by *Diploastrea heliopora*. These types of corals are slow-growing and generally more robust being able to withstand higher levels of sedimentation. Although sedimentation when it's to heavy can smother the coral. Foliose coral such as

Turbinaria sp. and *Montipora* sp were relatively rare. To determine all families and species of hard corals around Koh Rong Samloem a more detailed study will be started soon.

Photo 2 – Poritidae (background)

Photo 3 – Acoporidae

Photo 4 - Agariciidae

Photo 5 – Dendrophhylidae

Photo 6 - Faviidae

Photo 7 - Fungiidae

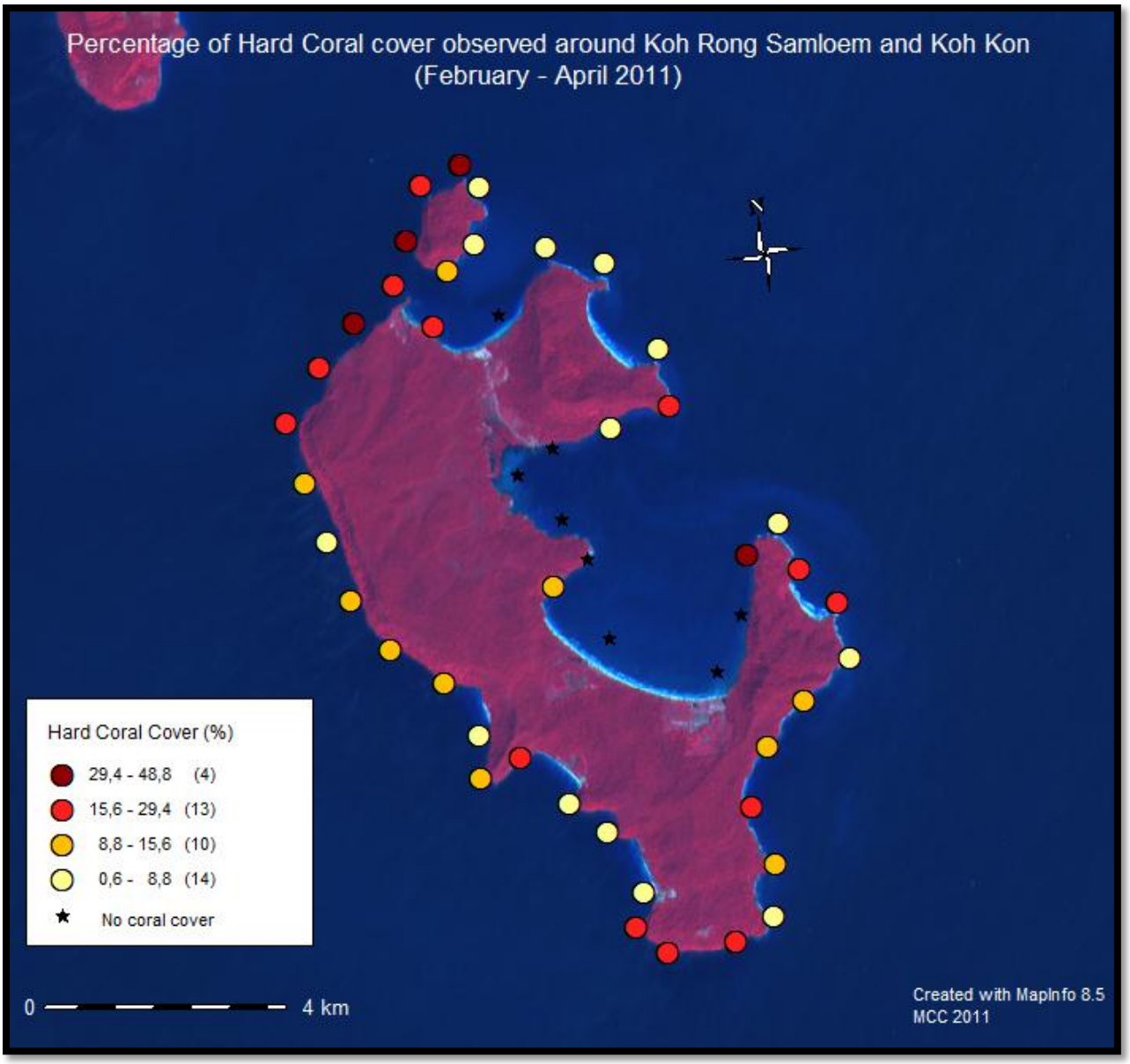


Figure 8 – Percentage of Hard Coral cover around the islands of KRS and KK

b. Impact on coral

When assessed individually, each coral damage category was found to be low with exception for dynamite damage at site KS35 that reached the medium damage category (**Figure 9 and 10**). Even, when the coral damage categories are summed together, the damage was low to moderate at most of the sites with exception of site KK05 where the impact was high. On Sites KS1, 3, 5 , 8 and 28 no visible coral

damage has been recorded. The effects of fishing in the form of discarded nets or other trash were found on most sites, however when present, it was relatively low. Signs of dynamite fishing have been recorded on three sites, while it was very low at site KRS29 it reached the category of medium impact at site KRS35 and KK05. However this damage did not result from recent dynamite fishing activities. Other trash such as cans and plastic were generally low on all survey sites. The damage resulting from boats anchoring on the reef was generally low within the transect line. However, anchor damage have been noticed outside of the transect lines on most sites, especially on popular diving sites around Koh Kon. For instance, on sites KK03 and KK04, anchor damage has been noticed outside the transect area and therefore not been included in the analysis; if it would have been recorded, it would have reached a medium to high impact severity.

The analysis showed that 46% of coral damage resulted from trash due to fishing activities (**Figure 11**), followed by general trash with 25%. 13% of the total damage resulted from boats anchoring on the coral reef while 11% resulted from inappropriate fishing methods with dynamite. Other coral damage, including predation by Drupella snails, was responsible for 5% of the total damage.

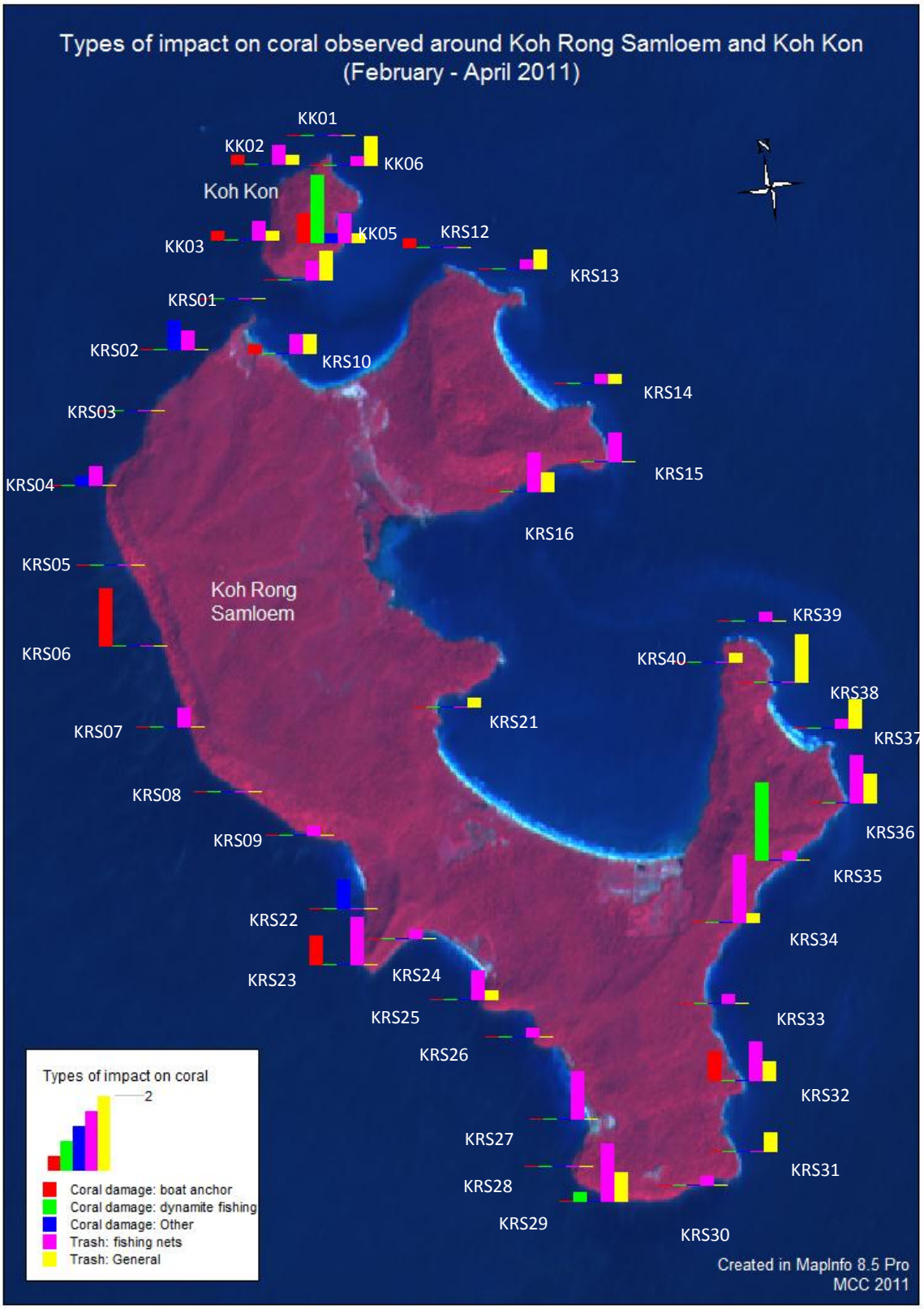


Figure 9- Type of damage observed around Koh Rong Samloem and Koh Kon (February - April 2011). Impact severity goes from 0 to 4 (highest severity). SPOT Image S.A., France, all right reserved

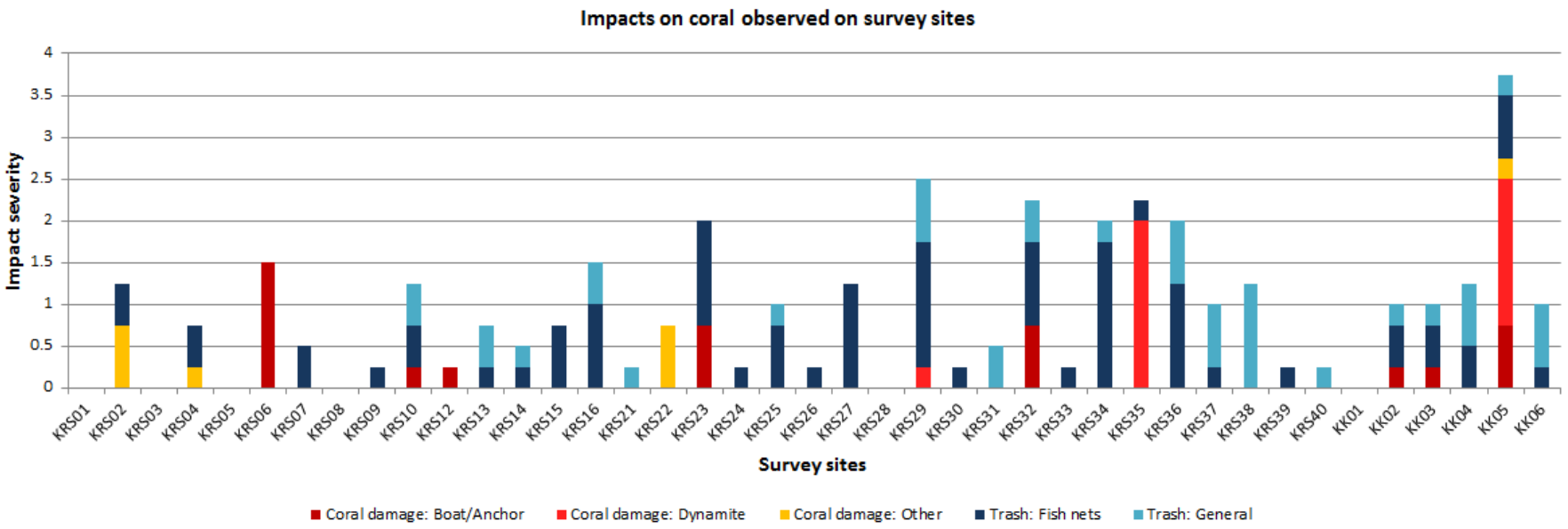


Figure 10 – Composition of mean percentage of coral damage of 5 different categories of the 49 survey sites. Damage was categorized in 4 groups: 0-none, 1-low, 2-medium and 3-high. Sites were no coral was present have been eliminated from this analysis as they would influence the reality, by altering the severity of impacts on corals.

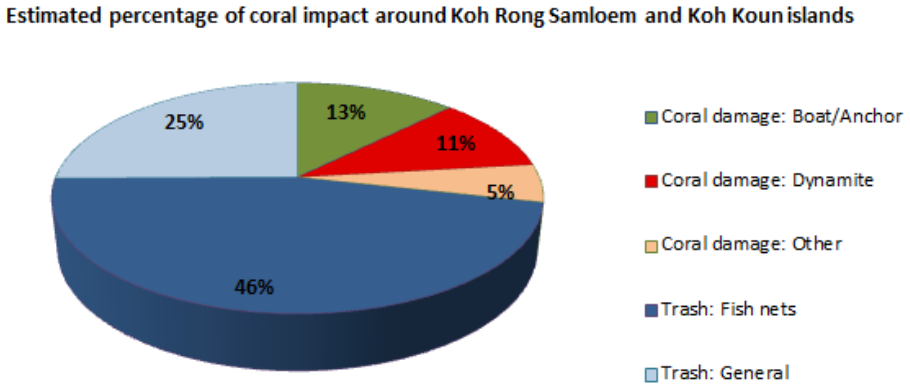


Figure 11 - Estimated mean percentage of coral impact of 5 different categories around Koh Rong Samloem and Koh Kon. Sites were no coral was present have been eliminated from this analysis as they would influence the reality, by altering the severity of impacts on coral.

c. Bleaching impact

Coral populations are slightly affected by coral bleaching reaching on average of 3 % around KRS and KK (**Figure 12**). That means that the majority (97 %) of the coral populations located within the area seem to be in general good condition and health.

The results of the bleaching study showed that the general degree of bleached parts within the corals colonies was in average 9% (**Figure 13**). Bleaching results from stress, to which corals are exposed, mainly resulting from rising sea surface temperatures; therefore, bleaching levels should be closely monitored in the future to assess the resilience of reef systems to regional, climate-change related impacts.

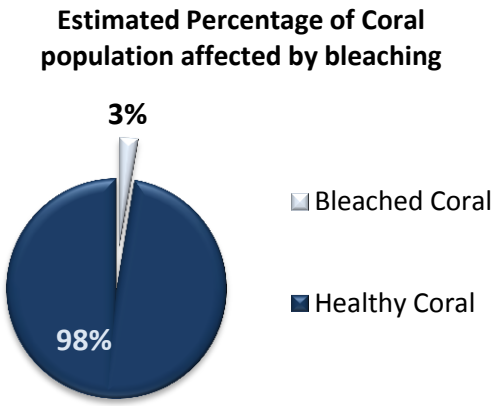


Figure 12 - Mean percentages of Coral Population that is affected or not by Bleaching around KRS and KK. Sites were no coral was present have been eliminated from this analysis as they would influence the reality, by altering the amount of healthy corals

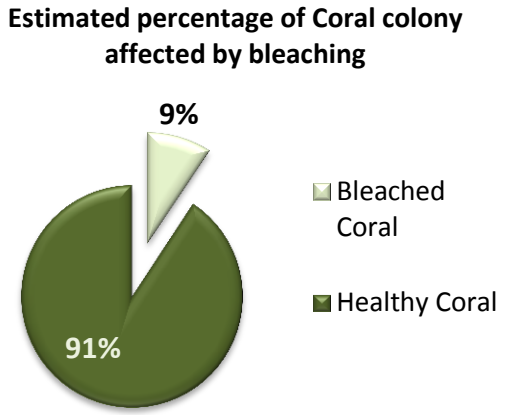


Figure 13 - Mean percentages of Coral Colony that is affected or not by bleaching around KRS and KK. Sites were no coral was present have been eliminated from this analysis as they would influence the reality, by altering the amount of healthy corals

d. Coral disease

About 2% of corals around KRS and KK are affected by the pink spotted disease (**Figure 14; Photo 8 and 9**). This disease is caused by the larval stage of the parasitic flatworm *Podocotyloides stenometra*. The flatworm has three life stages, the first is parasitic on a mollusc, while the second affects tissues of the coral, causing polyps to appear swollen and pink. This makes the polyp more vulnerable to predation by butterfly fish, which are the final host for the parasite. Once the infected polyp has been eaten by the butterfly fish, healthy polyps regenerate from the coral (third stage).

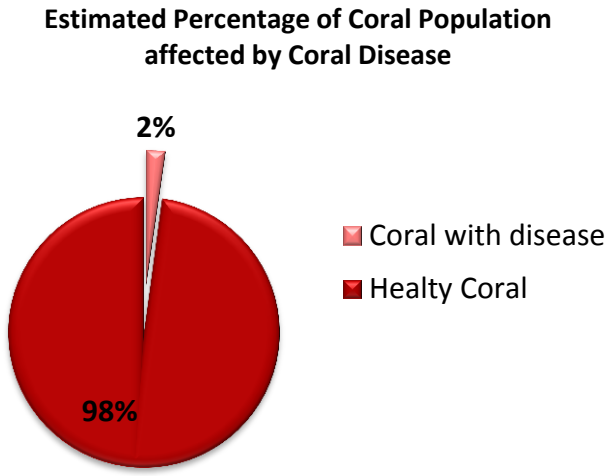


Figure 14 - Mean percentages of Coral Population that is affected or not by disease around KRS and KK. Sites were no coral was present have been eliminated from this analysis as they would influence the reality, by altering the amount of healthy corals.

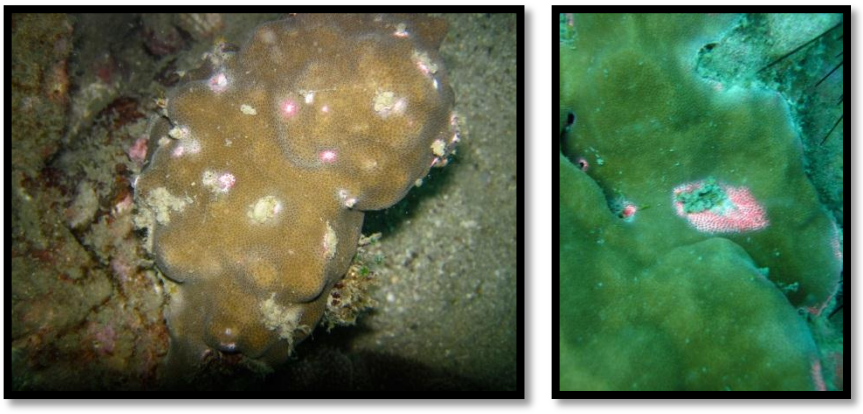


Photo 8 and 9 - Pink Spotted coral disease, Koh Kon 2011

e. Fish survey

Figure 15 illustrates the fish composition and abundance of the indicator species/families observed at study sites. There was a significant variability of species diversity and abundance between sites. It was found that Humphead wrasse, Bumphead parrotfish, Baramundi cod and Moray eel, were completely absent from all sites. In general, the diversity was quite low, rarely more than four indicator species/families were recorded (**Figure 18 and 19**). Sites KRS 04 and34 presented the highest diversity with 5 indicator families. The numbers of Groupers recorded during the survey dives was very low on all sites (less than 2 individuals per ha) and with an almost complete lack of large individuals (**Figure 17 and 19**). The number of Butterfly fish was low on all sites (less than 10 individuals/100m^2) (**Figure 18**). The numbers of Snappers presented a greater variability ranging from 38 to 0 individuals per 100m^2. Snappers (Lutjanidae), contributed the most to the composition of indicator fishes observed at the study area (41%), followed by the family of Butterflyfish (Chaetodontidae), Parrotfish (Scaridae) and Grouper (Serranidae) (33%, 18% and 7%, respectively). Individuals of Sweetlips (Haemulidae) were found contributing less (1%) to the present fish composition (**Figure 16**).

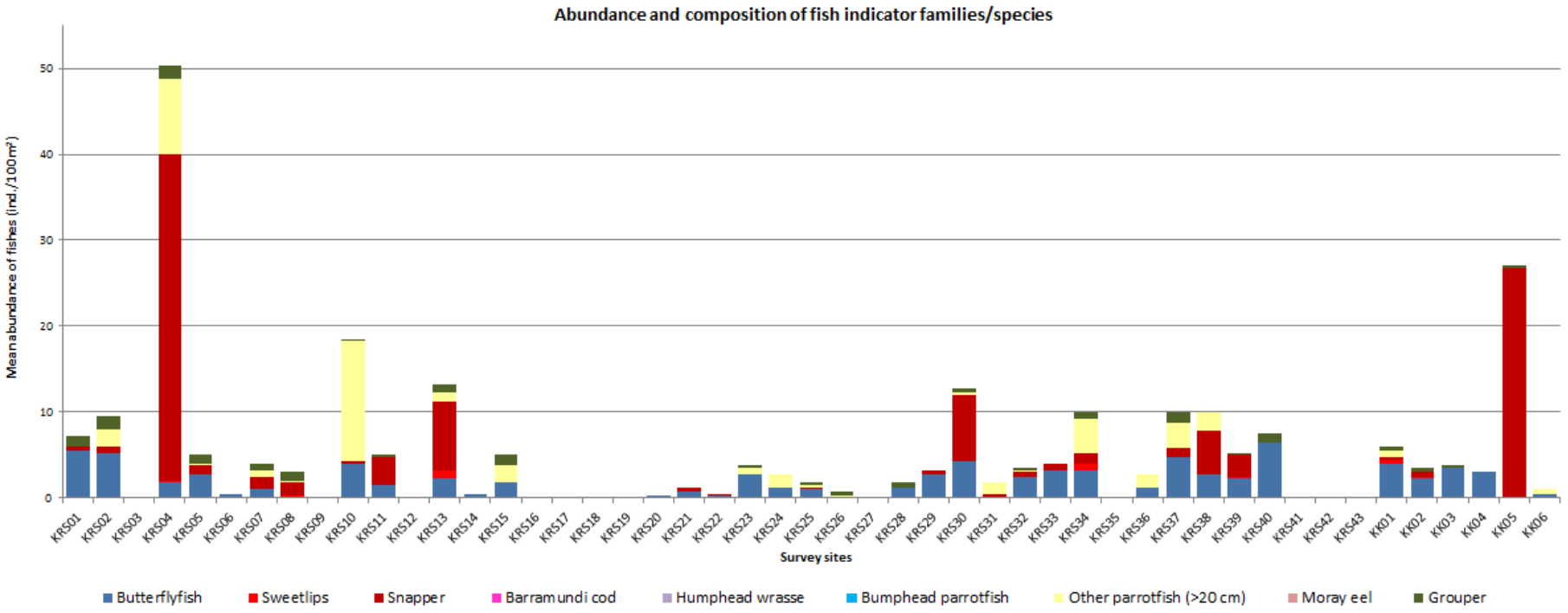


Figure 15 - Fish Abundance of Survey Sites. Mean number of individuals per100m^2 have been calculated for each site

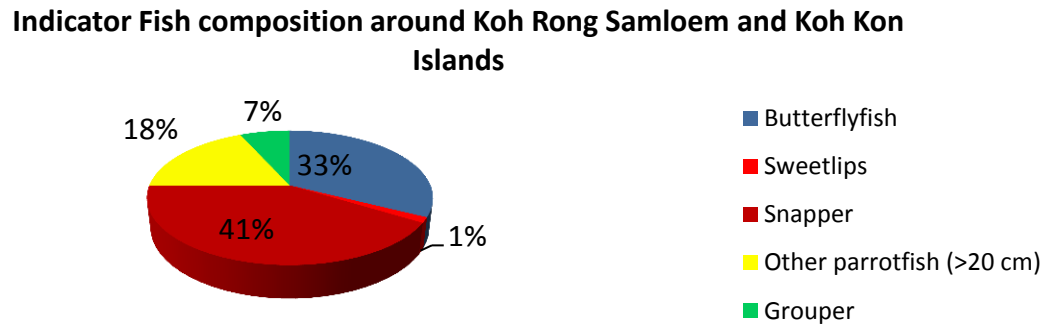


Figure 16 - Estimated Indicator Fish composition around Koh Rong Samloem and Koh Kon

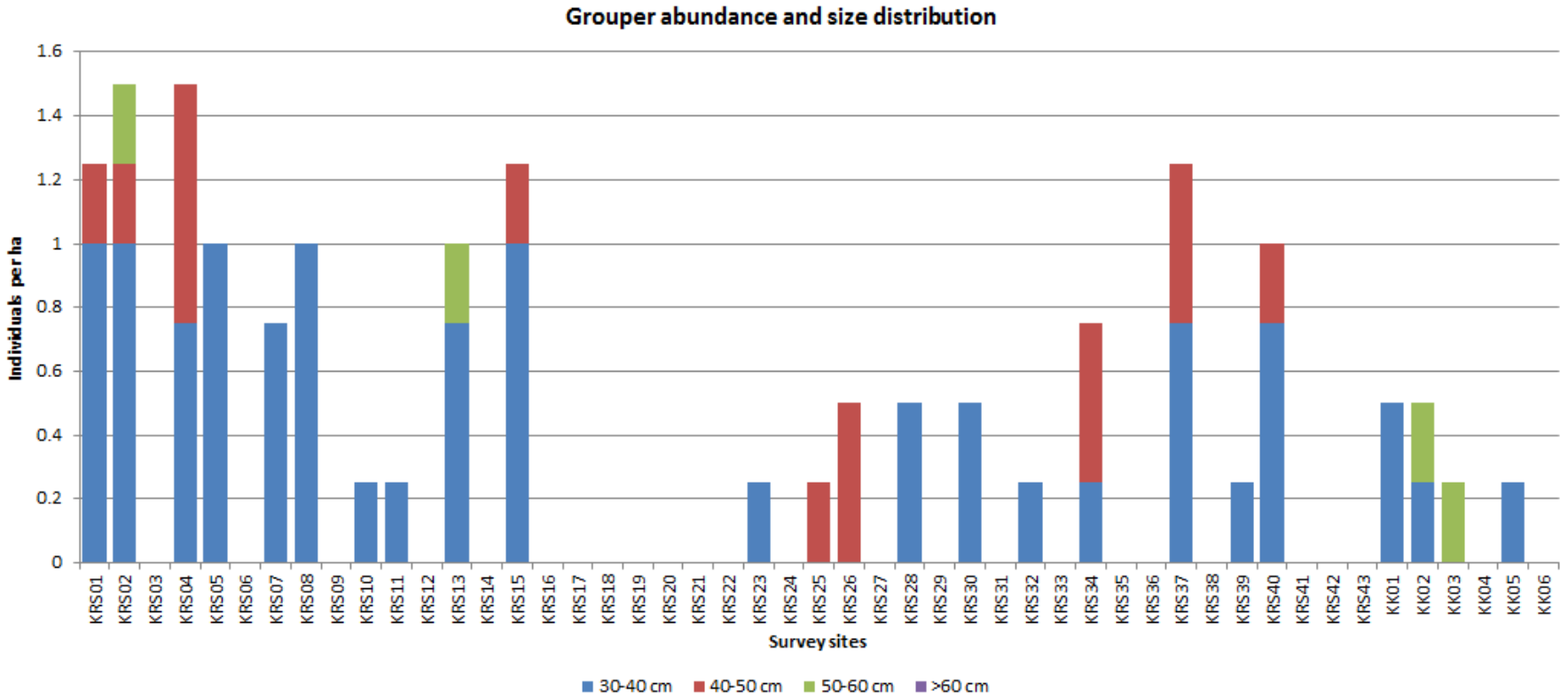


Figure 17 - Abundance and size distribution of Groupers around Koh Rong Samloem and Koh Kon. Mean number of individuals /100m^{2}has been calculated for each site

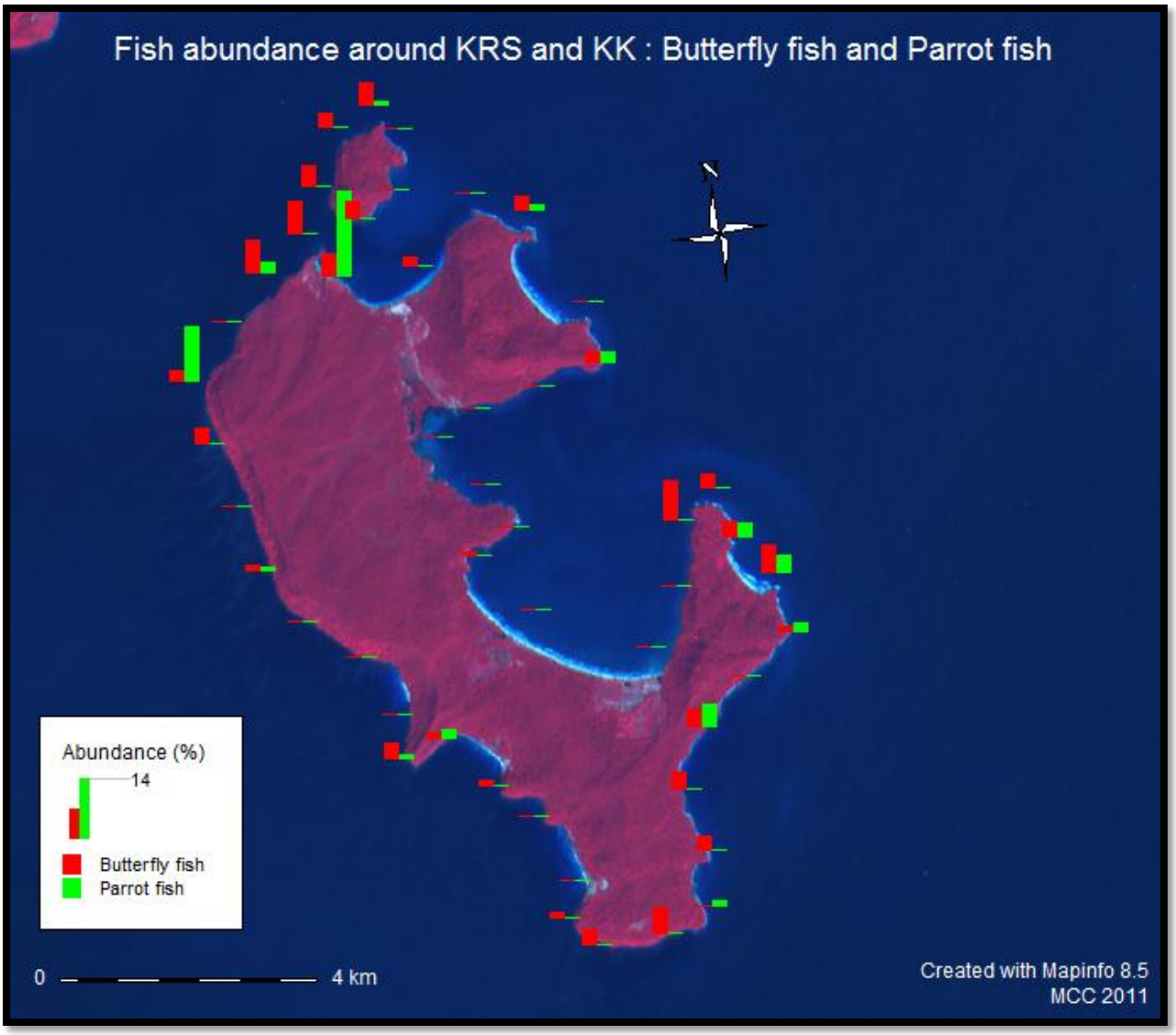


Figure 18 - Abundance of Butterfly and Parrot fish around KRS and KK

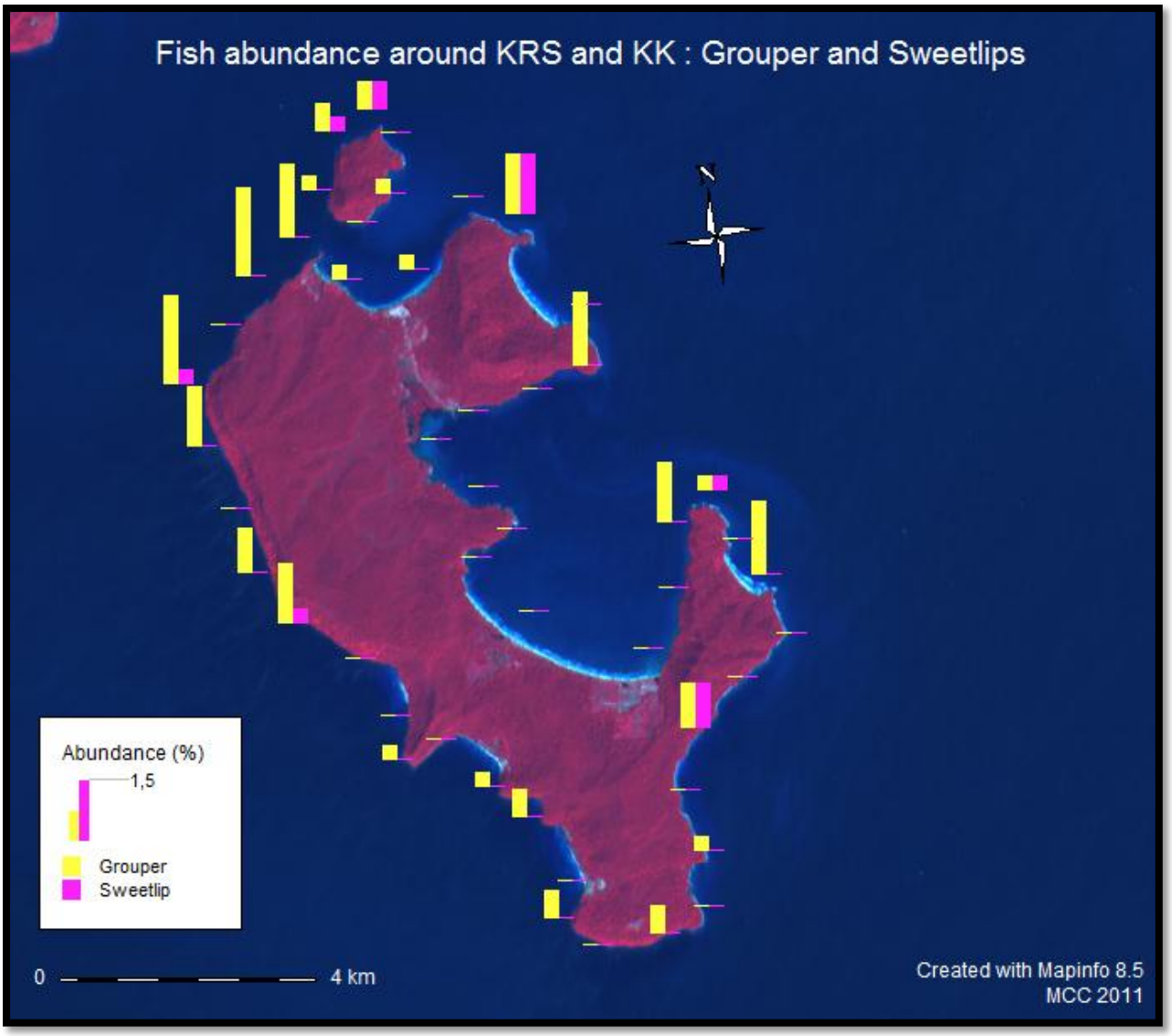
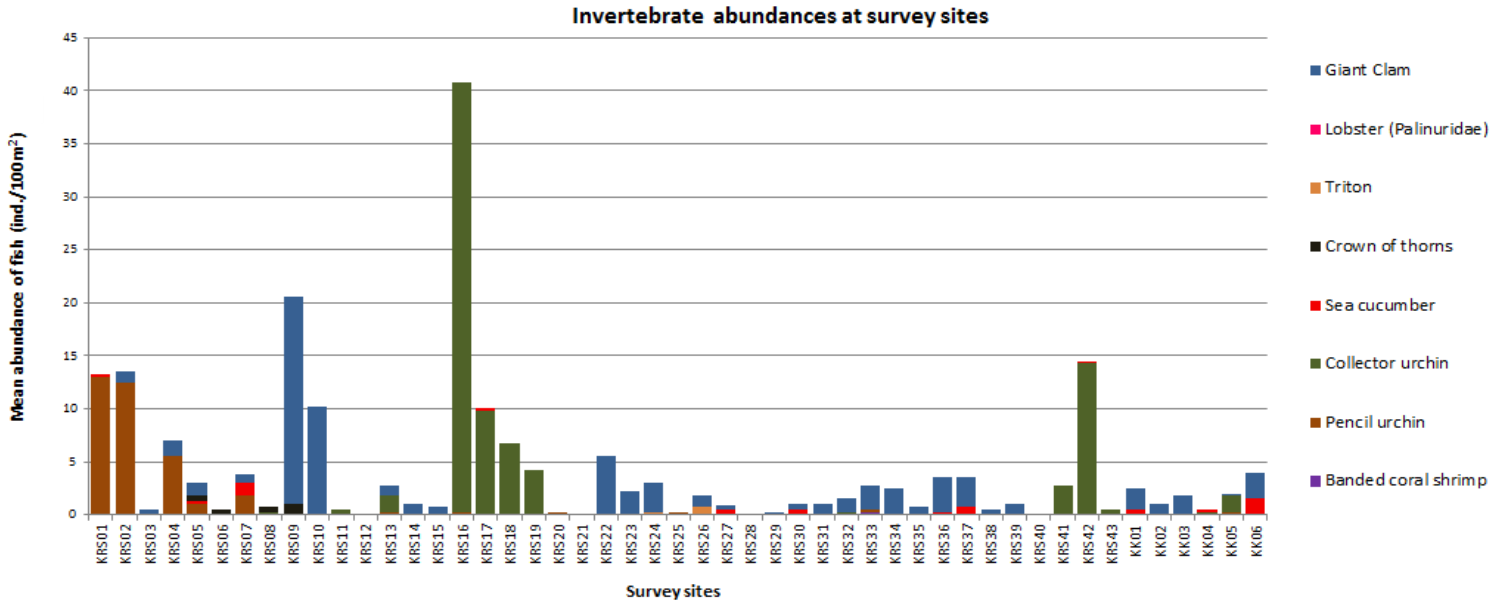


Figure 19 - Abundance of Grouper and Sweetlips around KRS and KK

f. Invertebrate survey

With the invertebrates it is possible to observe that there is very low species diversity at all surveyed sites (**Figure 20 and 21**). The abundance of invertebrates was extremely low, generally less than 5 individuals/100m^2. Site KRS16 had the highest number of individuals (41). However only one category

(Pencil Urchin) has been recorded (**Figure 20)**. Crown of Thorns starfish can form a major threat to coral reefs when they reach unusual high numbers. Fortunately, they were only found on Site KRS05, 06, 08 and 09 in scarcity. Sea cucumber abundances were low (<5 individuals /100m^2) or absent for all survey sites indicating severe over-harvesting. Triton shells and Banded Coral Shrimps were almost not existent 4 and 1 individual respectively were found during the survey. No lobster has been seen during survey period. Giant clams (*Tridacna* spp.) (**Photo 10**) are important reef filter feeders that contribute to the reef structure and rugosity. These organism have been found mostly of small size and in very low abundances (<10 ind. per hectar), with exception of site KRS09 were almost 20 individuals were present (**Figure 22 and 23**). This may result from a severe overharvesting as these are an important local food source and also targeted by foreign supplied air fishing vessels that regularly visit many of the Cambodian Islands and have been traditionally harvested for centuries. The highest number of pencil urchins was 13 individuals per hectare (KRS01) and there were many sites were none has been found. The highest number of pencil urchins was 13 individuals per hectare (KRS01) and there were many sites were none has been found.



20 - Invertebrate Composition of Survey Sites. Mean number of individuals /100m^2 has been calculated for each site. Diadema Urchins have been analyzed separately due to their elevated number

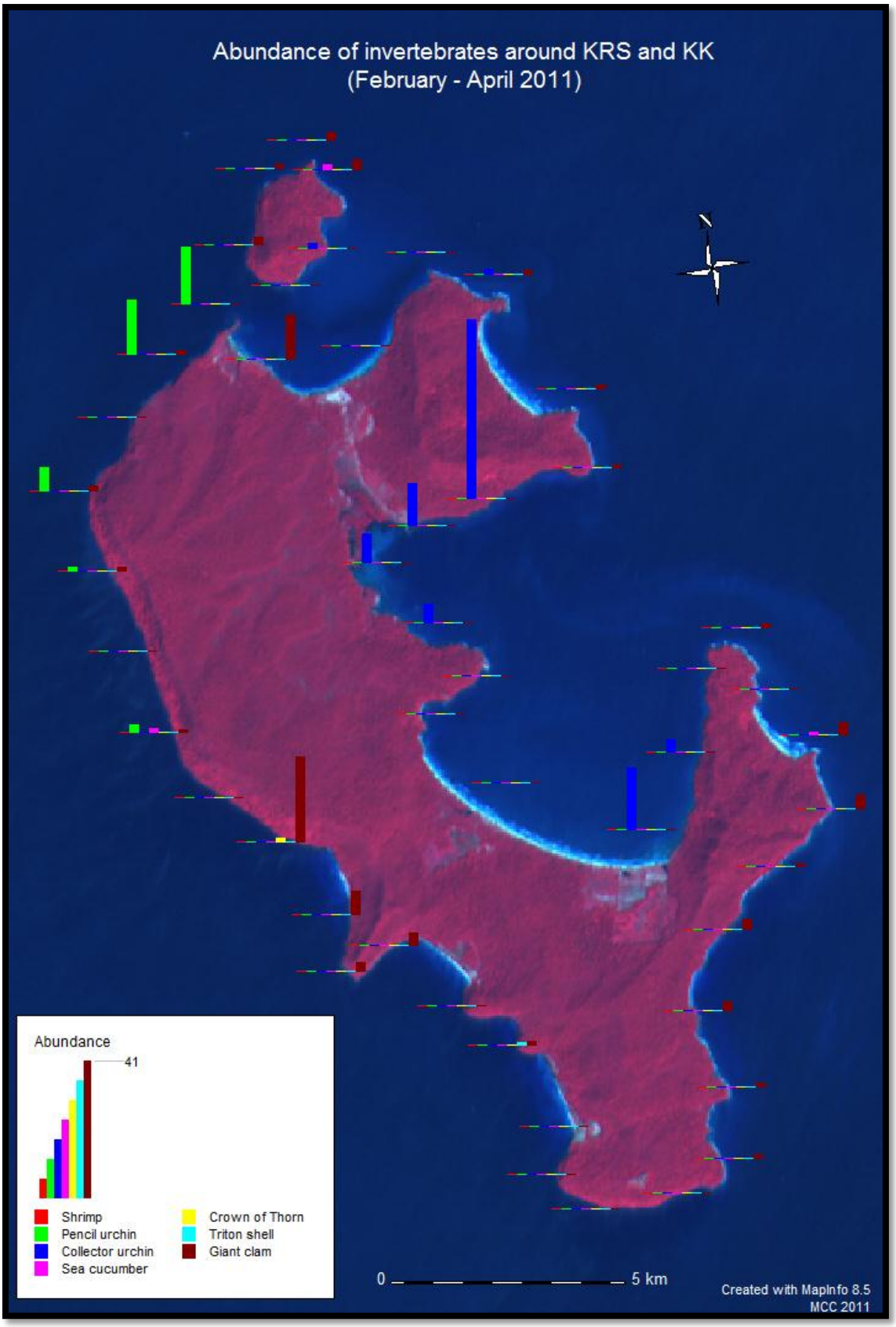
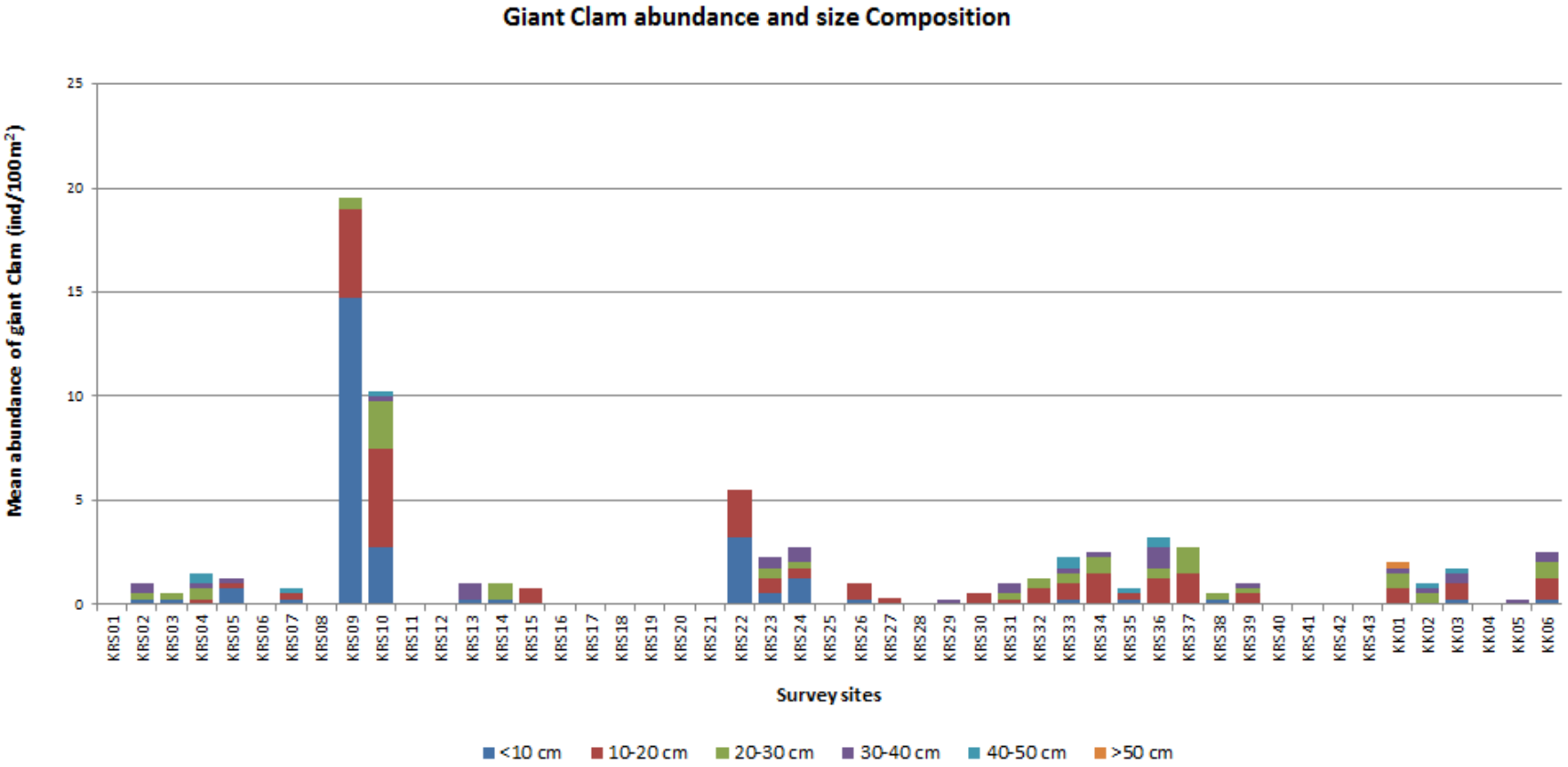


Figure 21 - Abundance of invertebrates around KRS and KK



22 - Giant Clam abundance and size distribution. Mean number of individuals /100m^{2}has been calculated for each site

High abundances of long-spine (*Diadema*) sea urchins were found on few surveys sites (**Figure 24 and 25**). Sites KRS02 and 04 had particularly high densities of these urchins while on site KRS16, 17,19, 26, 27, 35, 41 and 43 no single individual was found. These Sea urchins as they are algal-grazing, can play an important role in keeping the reefs clean of algae when there are few herbivorous fish around to fulfil this role.

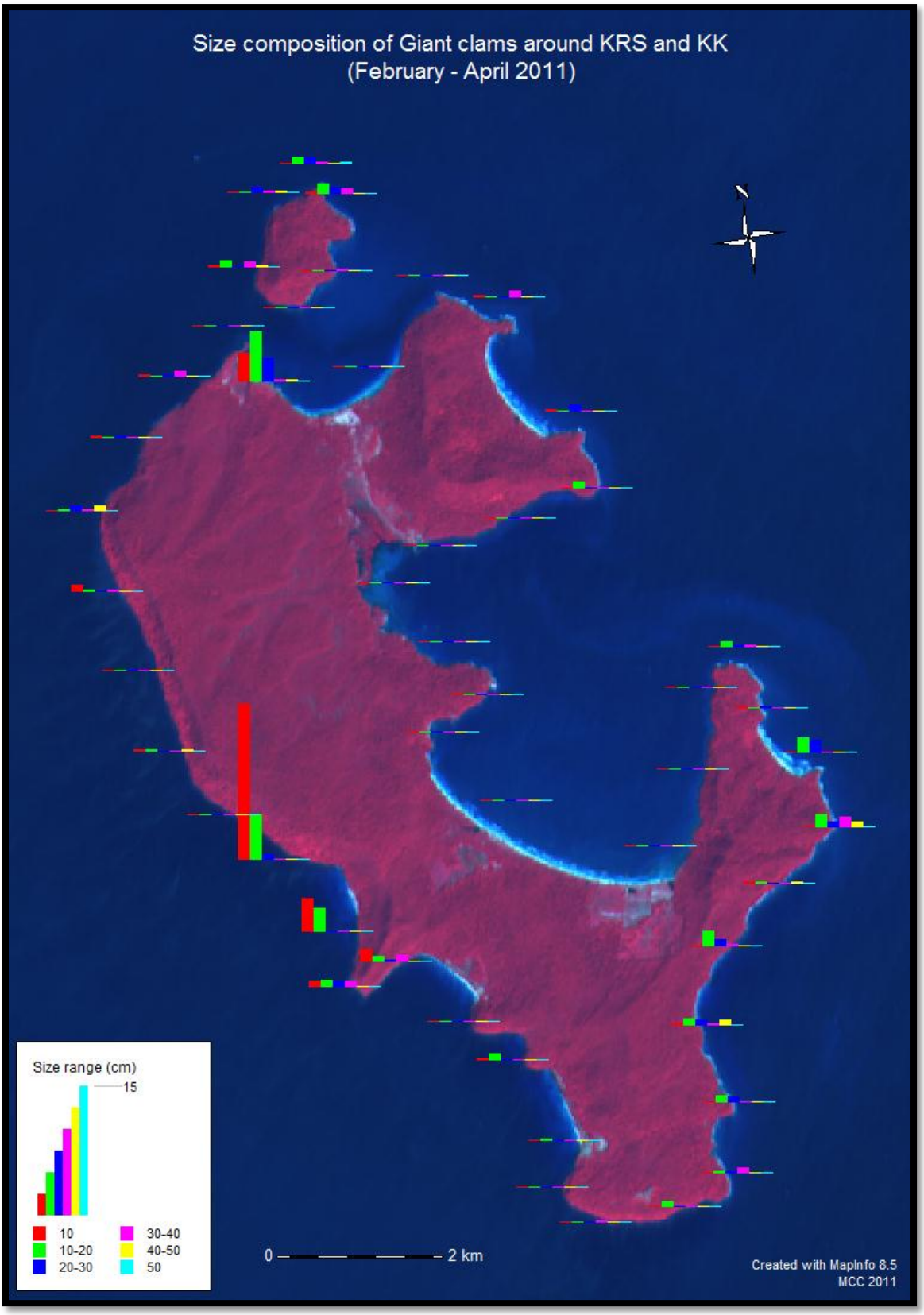
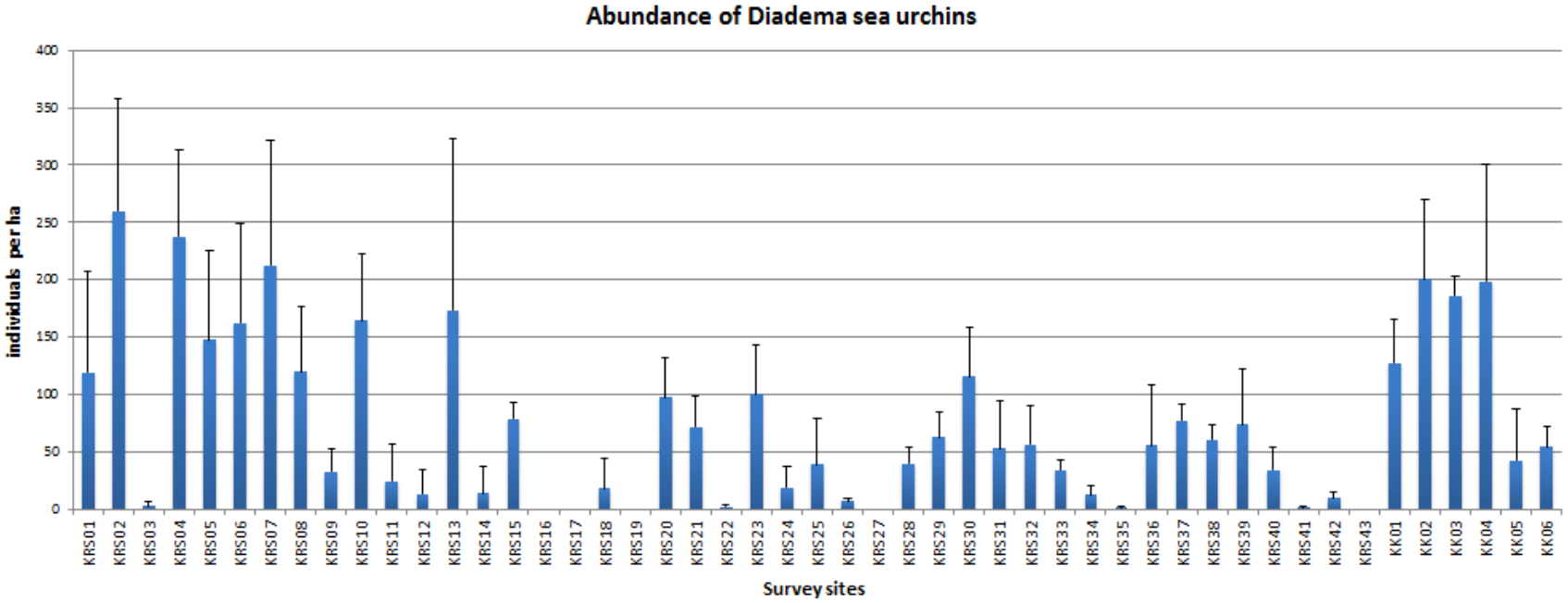


Figure 23 - Size composition of Giant clams around KRS and KK

Photo 10 - Giant clam, KRS



24 - Distribution of Diadema urchins of Survey Sites. Mean number of individuals /100m^{2}has been calculated for each site. Error Bars indicate standard error

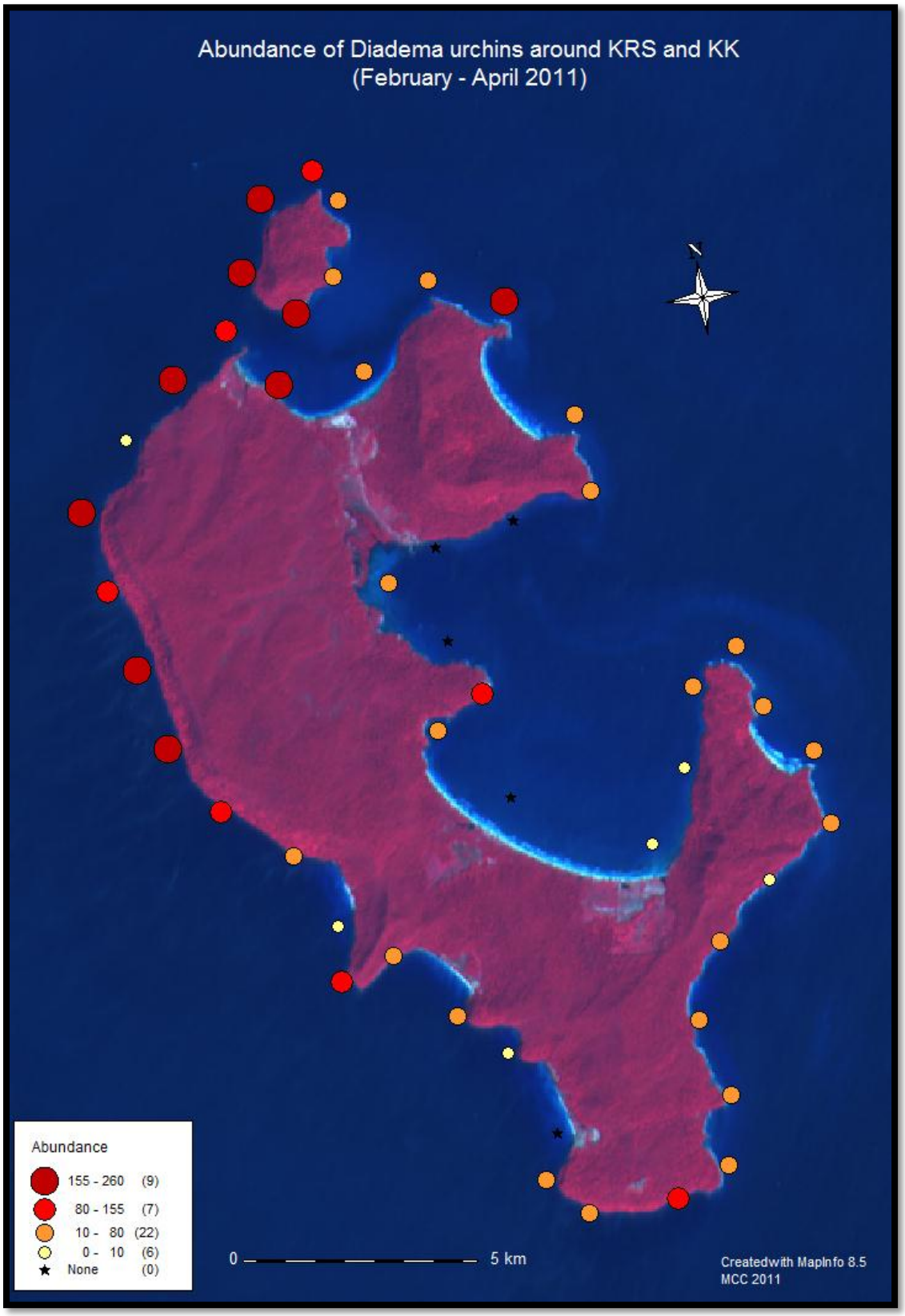


Figure 25 - Abundance of Diadema urchins around KRS and KK

III. FISHING AND OTHER ACTIVITIES

a. Local fishing within Koh Rong Samloem Community Fishing Area

Koh Rong Samloem Community Fishery ensures that only sustainable fishing gears are used within the Community Fishing Area (CFA) (**Figure 26**). As such, three main types of fishing can be observed in the area:

- Troll lines (squid)
- Squid traps (a few)
- Crab fishing (collapsible traps)
- Traditional line fishing
- Traditional fish traps

Koh Toch Community (Koh Rong), according to a recent socio-demographic survey, has been found to predominantly use crab nets: highly destructive, these are forbidden within the CFA thus requiring the fishermen to use them outside the area.

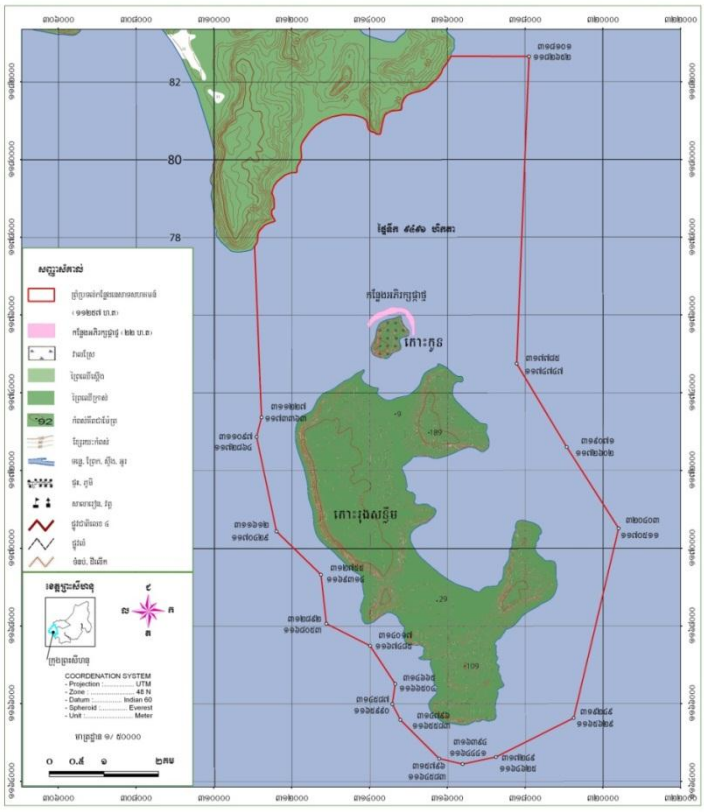


Figure 26 - Koh Rong Samloem Community Fishing Area (Courtesy FiA)

Daem Thkov (Koh Rong) is known to use mainly crab traps and some crab and fish nets. These activities greatly suffer from a high trawling activity in their area causing a significant decrease in catches.

Photo 11 - Traditional fish traps, KRS Photo 12 - Squid traps to be sold, KRS Photo 13 - Collapsible crab trap
Photo 14 - Traditional line fishing, KRS

b. Illegal fishing / threats

Threats to the marine environment have been identified through observations during marine surveys, on-site observations (Koh Rong Samloem Community Fishery Patrols) and coastal stakeholders' observations during the FiA-RFLP/FAO Training Course on Marine Biology, Marine Ecology, Safety at Sea and MCS in December 2010 (**Photo 15**) .

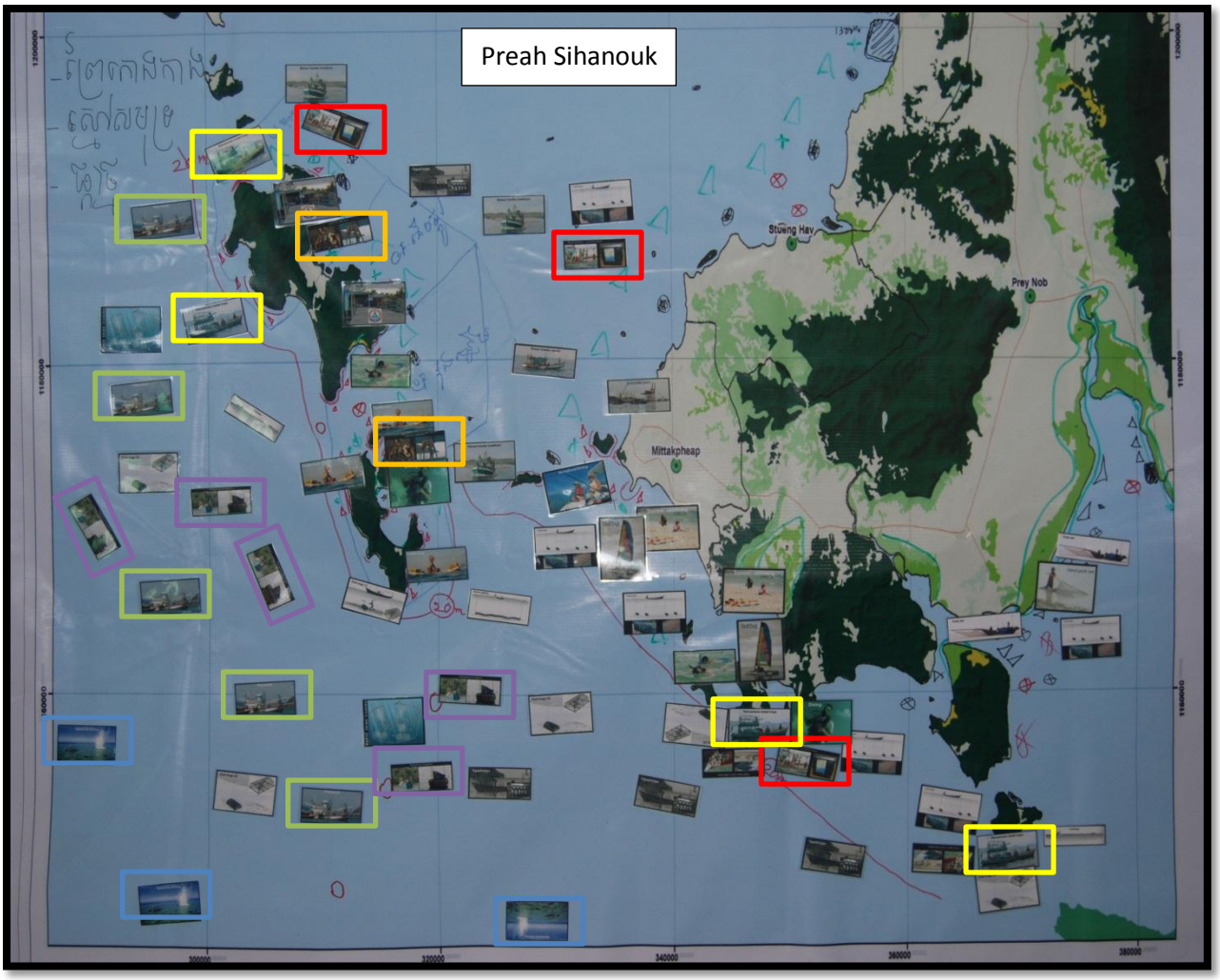


Photo 15 – « Locate activities within your cantonment area »: fishing activities (legal and illegal) as well as marine tourism-related activities were placed by the participants on a map of their cantonment area. Here, we can observe illegal inshore trawling (red), Vietnamese metal traps (yellow), Thai trawlers/"light boats" (green), dynamite fishing (**blue**), Vietnamese basket boats (purple) and seahorse collecting (orange).

i. Inshore trawling

"Trawl gear effects the environment in both direct and indirect ways. Direct effects include scraping and the substrate being ploughed, sediment re-suspension, destruction of benthos, and huge incidental by-catch. Indirect effects include post-fishing mortality and long-term trawl-induced changes to the benthos. A trawling boat has the capacity of devastating an entire ecosystem in a few hours, leaving only sediments in an area that will then need years to recover. Seahorse populations are particularly concerned by the removal of their microhabitats; if not caught by the same nets, they are left defenseless without protection from natural predators and strong currents. The removal of sea urchins (*Cidaridae*) and other microhabitats has been damaging to the entire unique ecosystem of the Corral[1]." (P.Ferber, M. Skopal, 2010).

Photo 16 and 17 - Boat illegally trawling inshore areas off Koh Kon (no visible boat registration number), KRS 2011

Photo 18 – Trawling by-catch, KRS 2008

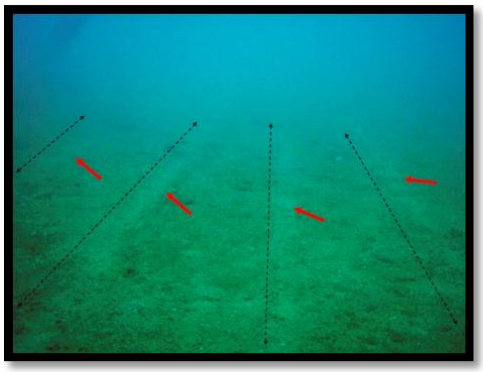


Photo 19 – Visible trawling mark on a devastated substrate, KRS 2008

[1] Seahorse breeding ground near Koh Kon/Koh Rong Samloem

Koh Rong Samloem fisheries community has managed to lower the number of illegal trawling vessels operating within the daytime, but still suffers regular nighttime incursions which are much harder to tackle, due to safety reasons of operating at night.

ii. Foreign illegal fishing / poaching

Foreign illegal fishing and poaching have been witnessed around the islands of Koh Rong Samloem and Koh Kon. Although almost eradicated during the day time, they still regularly occur at night time despite the effort of Koh Rong Samloem Community Patrol group. Several types of illegal fishing have been observed:

- Air-supplied fishing (**Photo 20, 21, 22 and 23**)

Boats have been caught within the Community Fishing Area complete with supplied air hoses and hacksaws with several bundles of black whip coral. Coral harvesting negatively impacts the reef as the fishermen select only this one specific species, not allowing the reef to diversify. They also acquire it by walking on the reef, destroying all the substrate they tread on, including neighboring corals, sponges and other benthic species endangered and protected species. Coral is not normally the only species these fisherman collect, they also pick up shells such as abalone, pen shells and murex (*Muricidae*) and endangered species such as giant clams, commercial tops and seahorses.

Photo 20 and 21– Vietnamese boat caught by Community Patrol group: equipment and catch confiscated by local authorities, KRS April 2011

Photo 22 – Giant clams carved out: Vietnamese boat, KRS 2011
Photo 23 – Vietnamese fisherman holding a supplied air hose for his diver, KRS 2007

- Dynamite fishing

Dynamite fishing used to be regular around the islands but over the past 3 years the numbers of incidents has dropped and it is now a rare occurrence, though it doe still occasionally happen.

- Cyanide fishing

Cyanide fishing still goes on around Koh Rong Samloem though with less frequency than a few years ago, this type of fishing is usually carried out by illegal Vietnamese fishing vessels (**Photo 24 and 25**).

Photo 24 – Horseshoe crab and shark suckers caught with cyanide, KRS 2008.
Photo 25 – Dead by cyanide, then used as bait.

iii. Crab nets and other bottom weighted gillnets

"Crab nets are bottom weighted nets that can be several kilometers long. They have a significant impact on the ecosystem as they collect not only crabs, but also corals, undersized fish and endangered species such as seahorses (**Photos 26 to 29**). Ghost nets (**Photo 30 and 31**) (nets that have been lost accidentally, deliberately discarded, or simply abandoned at sea) constitute a real threat to marine life as they move according to the currents and tides, continually fishing indiscriminately, not only catching threatened species but undersized and protected fish as well." (P.Ferber, M. Skopal, 2010).

Photo 26, 27 and 28 – Crab net by-catch, KRS

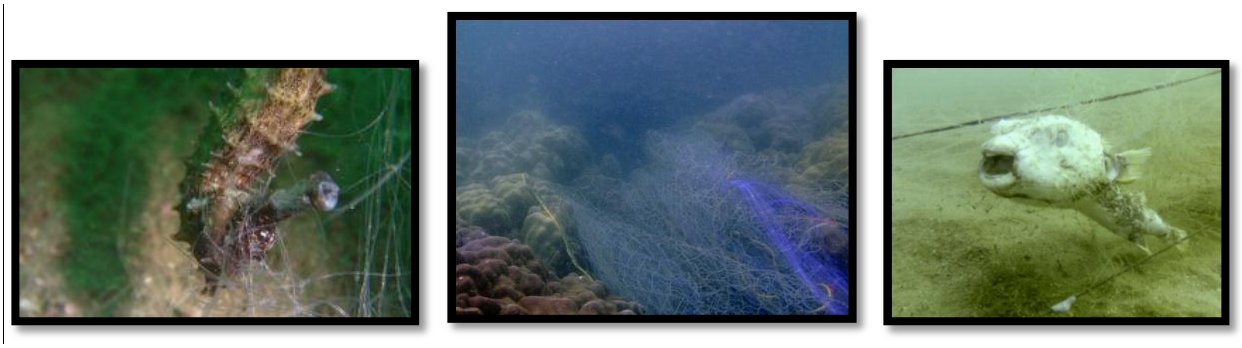


Photo 29 – Seahorse caught in a net, KRS
Photo 30 and 31 – Ghost nets, KRS

Most activities involving crab nets have been stopped within Koh Rong Samloem Community Fishery Conservation Area, though occasionally crab net vessels are caught at night by the community patrols and informed that it is no longer possible to fish inside the designated conservation area.

iv. Anchoring on the reef

When boats anchor on coral, be it to fish, dive or to shelter from bad weather, the anchors often get stuck between two pieces. In attempting to remove the anchor from the reef, the boat will often move back and forth in order to violently jerk the anchor free. Doing this, the anchor will often snap off large sections of coral or sponges. On occasion, the coral can re-establish itself through this fragmentation and help the reef to grow. Unfortunately, it has been observed that the coral will most likely die from this stress, leaving nothing but a skeleton.

Photo 32 – Dive operator anchoring in a reef area and direct damage on sponge, 27/04/2011

Our divers and survey teams have been reporting a severe increase in anchor damages during the last high season, especially on popular dive sites where diving boats have been seen anchoring every day, sometimes several times per day. This situation constitutes not only a threat to fisheries but also to marine tourism, with visitors complaining about dive operators' behaviour and lack of environmental awareness, thus affecting the reputation of marine tourism quality in Cambodia. Strict law enforcement and the installation of mooring buoys need to be urgently looked at.

c. Community-Based Marine Resource Management

i. Koh Rong Samloem Community Fishery Patrols

Koh Rong Samloem Community Fishery (CFi) has been actively patrolling within its CFi boundaries since 2008 with the assistance of MCC, a detailed record of patrols has been kept by the Community and extensive photographic documentation has been kept by MCC. These patrols have been the most important part of reversing the trend of destruction around the Island. When the patrols first began in 2008, daily patrols would find 5 to 10 illegal activities happening within its patrol range. The patrols have progressed over the last three years and made an impressive impact on illegal activities: Community Fishery patrols can now go through a whole month with only a few illegal incidents to deal with. The biggest problem currently is the illegal night time activities which are much harder to deal with due to safety concerns.

ii. Marine Ecotourism: increasing livelihoods

KRS Community Fishery (**Figure 27**) has been developing marine ecotourism as an alternative source of revenue to fishing over the past four years. As such, it has been able to reduce the pressure on the marine environment while increasing the livelihoods of the community members. The Community is currently seen as a model of Community-Based Marine Resource Management with an ongoing successful experience in Marine Conservation, Sustainable Fishing and Marine Ecotourism. The creation of a Marine Fisheries Management Area will be supported by and could largely use the experience of the community members in managing such an area.

Figure 27 – Koh Rong Samloem Community Fishery's emblem

GENERAL CONCLUSION

In general, the health condition of corals around KRS and KK was good. However, observations show that:

- Bleaching and coral disease have been found in low percentage but, these should be closely monitored to allow management practices if necessary.
- The low number of fish and invertebrate abundances are signs of severe overfishing.
- Anchor damage is highly visible and dramatically increasing, mostly at sites were tourist scuba diving companies are operating.
- High Sedimentation is a direct threat to the health of the marine ecosystems around Koh Rong Samloem.
- Illegal fishing activities are still negatively impacting the marine health around the Island.

Furthermore, degrading environmental quality and anthropogenic stress, for instance in the form of eutrophication and sedimentation, could potentially facilitate the spread and virulence of coral disease (Harvell et al. 2007).

A study in the Philippines reveals that coral reefs within effectively managed marine protected areas (where reef fish populations are protected from all harvesting and fishing activities) exhibit significantly lower levels of disease than adjacent coral reefs where fishing takes place. The study suggests that the reduction of fishing pressure on reef ecosystems, for example through the establishment and enforcement of marine protected areas, presents a promising approach to managing coral disease (Raymundo et al. 2009).

REFERENCES

Beeden R, Willis BL, Raymundo LJ, Page CA, Weil E (2008) Underwater Cards for assessing Coral Health on Indo-Pacific Reefs. CRTR- Coral Reef Target Reasearch &Capacity Building for Managment Program.

Bruno JF, Selig ER (2007) *Regional Decline of Coral Cover in the Indo-Pacific:Timing, Extent, and Subregional Comparisons*. PLoS ONE 8:e711

Bryant D, Burke L, McManus J, Spalding M.(1998*). A Map-based Indicator of the threats to the world's coral reefs*. World Resources Institute. Washington D.C. USA

GCRMN (2004) *Status of Coral Reefs in East Asian Seas Region.* Australian Institute of Marine Science

Harvell CD, Jordan-Dahlgren E, Merkel S, Rosenberg E, Raymundo L, Smith G, Weil E, Willis B (2007). Coral disease, environmental drivers and the balance between coral and microbial associates. Oceanography, 20:173-195.

Jones GP, McCormick MI, Srinivasan M, Eagle JV (2004) *Coral decline threatens fish biodiversity in marine reserves.* Proc Natl Acad Sci USA 101:8251–8253

Kim S, Chou LM, Tun K (2004) *1st Draft Report on The Coral Reefs of Cambodia: Present State of Information and Management Capacity.*

Raymundo LJ, Halford AR, Maypa A, Kerr AM (2009). Functionally diverse reef-fish communities ameliorate coral disease. PNAS 106:17067-17070.

Touch, S.T. (1995). Present Status of Fisheries in Cambodia and the Development Action Plans. The Department of Fisheries. Phnom Penh.

Wheeler M, McNamee PJ, Kosal M () Objectives off ADB5712REG *Costal and Marine Environmental Management in the South China Seas, PHASE II- CAMBODIA COMPONENT.* International Symposium on Protection and Management of Coastal Marine Ecosystem

Wilkinson, C., Souter, D. (2008). Status of Caribbean coral reefs after bleaching and hurricanes in 2005. Global Coral Reef Monitoring Network, and Reef and Rainforest Research Centre, Townsville, 152 p.